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Foreword

Construction is a major industry throughout the world, accounting for a sizeable proportion of most countries' Gross Domestic Product (GDP). Furthermore, the importance of the construction sector is not only related to its size but also to its role in economic development. It produces the facilities that house a wide variety of human activities, as well as the infrastructure that connects these facilities into an increasingly complex network.

Construction plays also a crucial role in Turkey's economic development accounting for well over 6 % of GDP and employing some 1.3 million people. When the direct and indirect impacts on other sectors are taken into account, the construction sector's share in the Turkish economy reaches 30%. In 2007, 10% of the "Top 225 International Contractors" announced by the leading international industry magazine "ENR - Engineering News Record" were Turkish companies. With 22 companies among the top 225, Turkey ranked third in the world after United States and China.

Within this respect; the fifth International Conference on Construction in the 21st Century (CITC-V) has a very special theme which is "***Collaboration and Integration in Engineering, Management and Technology***" and presents a global approach to the construction industry which implies that studies and implementations related to the construction sector are multi-disciplinary in nature. Collaboration and integration in engineering, management and technology is a rather complex and important challenge. It requires planning, financing, selection of appropriate construction materials/technology and management, which have to be all performed with success.

On the other hand; the statistical documentation of the CITC-V conference is as follows: More than 300 abstracts have been received. To ensure the high quality of CITC conference series, after a careful review of the Technical Committee, 215 of them are found eligible to be published in the conference proceedings. Currently 35 countries have been represented by their 180 delegates in the CITC-V conference. The future of built environment will greatly depend on the knowledge generated through education and experience. Thus, this conference will be an instrument to disseminate the high level of information provided by the authors. The proceedings of this conference will be a reference document to help maintaining the up to date information of academics and construction professionals.

Due to its strategic geographical location, Turkey is acting as a kind of natural bridge between the east and the west. We hope that, the same bridge function could also be maintained within the context of this conference and experiences gained throughout the world will disseminate to other countries, through this conference.

We would like to extend our deepest gratitude to many colleagues, associates and sponsor companies/institutions that have contributed and thus made this conference possible and successful. Also, we would like to say a sincere welcome for the participants who are here as our guests and decided to join in this important world event.

Finally, we wish all of you a very successful conference and enjoyable stay in Istanbul.

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Istanbul, Turkey, May 2009

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Keynote Speech 1
The Risk of Contractor Default

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Abstract

One of the most important risks in the construction process is the risk of contractor default. It is in the interest of contractors to understand failure patterns and why construction companies fail, and to predict company decline and prevent failure. It is in the interest of construction owners to protect themselves against contractor default, and to identify contractors that are likely to default. It was found that company failure is age dependent; that there are liabilities of newness, adolescence and smallness; that most causes of failure can be prevented by short-term management action; that it is possible to predict the state of decline of a company by using non-financial data; that the owner can use intelligent/economic protection against contractor default; and that subcontractor default may be an important part of the equation.

Keywords

Risk management, Contractor default, Business failure, Company decline, Predictive models

1. Introduction

The research literature focuses on company **success** factors. Yet, lessons must be learned from business failures too. One of the most important risks in the construction process is the risk of contractor default (Arditi *et al.*, 2000). The owner normally transfers this risk to the contractor who protects himself by transferring it to surety companies. The fact of the matter is that the fees paid by the contractor to purchase surety bonds are factored in the contractor's overhead expenses and are therefore reflected in the contractor's final offer. The owner who accepts this offer is actually paying for the transfer of the risk to a third party. Whether it is worthwhile to retain this risk or to transfer it at some expense is a rather difficult question especially for public agencies where public officials are bound by existing laws of accountability.

“Business failure“ refers to a business that ceases operations following bankruptcy, ceases operations with losses to the creditors after such actions as foreclosure, voluntarily withdraws leaving unpaid debts, is involved in court actions such as reorganization, or has voluntarily compromised creditors. According to Dun and Bradstreet's 1997 data, the total value of failure liability in the construction industry was \$2,021,220,115, which constituted 5% of the total value of failure liabilities in the U.S. in that year. Furthermore, the failure rate per 10,000 firms was 88 for all industries whereas it was 116 for the construction industry in 1997. The same pattern of higher numbers of business failures in the construction industry is observed consistently in the previous years as well (Dun and Bradstreet, 1989-1993). Given the severity of the implications in terms of liabilities created by failures and the sheer numbers of business failures in the construction industry, it is believed that at least as much research into business failures is justified in the construction industry as research into success recipes.

The objectives of the set of studies that were conducted at IIT over a period of ten years (1995-2005) were set as follows:

- Understanding contractor failure patterns

- Finding why construction companies fail
- Predicting decline and preventing failure
- Protecting owner against general contractor default
- Protecting general contractor against subcontractor default

2. Contractor Failure Patterns

The contextual factors of a company, particularly age and size, are commonly argued to have important implications on its survival chances. These implications were explored by Kale and Arditì (1998) in the context of the construction industry by analyzing the age distribution of failed construction companies and computing age-specific failure probabilities over a ten-year period 1985-94.

Organizational ecology which builds on environmental selection arguments postulates that as an organization ages its chances of failure decrease as a result of subtle processes which influence organizations (Hannan and Freeman, 1977, 1984). Therefore failures among newly established organizations are more common compared to older ones. The objective of Kale and Arditì's (1998) study was to explore the liabilities of newness, adolescence, and smallness on business failures in construction organizations by building on environmental selection arguments advocated by organizational ecologists. By doing so, the objective was not to reject the adaptationist perspective (Child, 1972; Bourgeois, 1984) which supports the view that companies' strategic leaders can influence their companies' performance and hence generate failure or success, but to gain insights into the extent of the influence of primary subtle processes underlying environmental selection forces.

There are several important conclusions of Kale and Arditì's (1998, 1999) research. Firstly, the study reveals an age-dependent pattern of failure in the U.S. construction industry in which the risk of business failure increases in the first few years of a company's life, reaches a peak point and decreases thereafter as the company ages (see Figure 1). However it should be noted that organizational learning and gaining of legitimacy can fend off the risk of failure only to a certain extent and certainly not all potential risks a company can face through its entire organizational life.

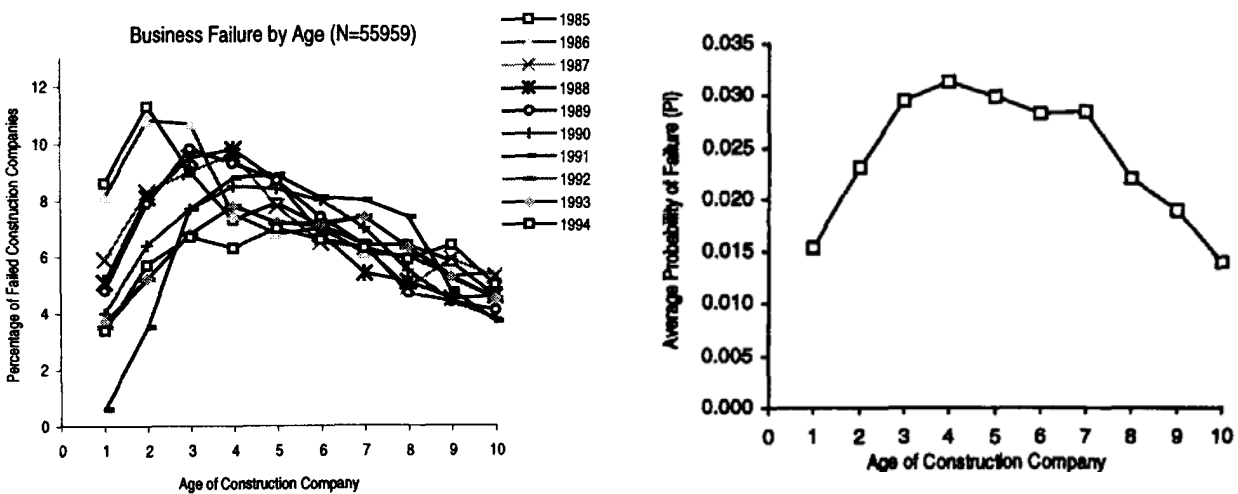


Figure 1: Failure Probabilities by Age

Secondly, the increasing risk of failure in the early life of construction companies can be attributed to the possible existence of an initial assessment period also referred to as the *adolescence* period. During this period, the performance achieved by the company is assessed and a decision is made either to continue

with the construction business or to exit from the industry. The heterogeneity of the companies' resources and differences in the decision-makers' time horizon and performance criteria suggest that this assessment period may be different for each individual company.

Thirdly, newness which implies lack of organizational learning and legitimacy coupled with smallness appear to be the primary factors underlying the high probability of failure of construction companies. Organizational learning and gaining of legitimacy increase the survival chances of a construction company. The scarcity of resources, particularly of financial resources, increases the impact of the selection forces that act negatively on small companies. Lack of legitimacy and lack of financial resources constitute the major obstacles against the survival of newly established construction companies. It is evident from the research that overcoming the liability of adolescence is not as easy as entering the construction industry.

Fourthly, in a new era of increasing turbulence, the survival and success of construction companies will not only be depending on improving their learning capabilities. In order to make the shift from an efficiency driven orientation to a market driven orientation, companies must be aware of the limitations of organizational learning and must avoid the trap of organizational myopia.

Finally, the research findings provide some support to the environmental selection arguments in the context of the construction industry but should not be considered as the rejection of the adaptationist perspective. Indeed, it is quite possible that the individual characteristics of organizational leaders do have an impact on the success/failure of an organization.

3. Why Do Construction Companies Fail?

3.1 The Environment/Response Model

Failure is the outcome of a complex process and rarely depends upon a single factor. Organization theorists from one school to another define the fate of the firm with different paradigms. Organizational ecologists (Hannan and Freeman, 1977, 1984) favor environmental determinism and claim that the fate of a firm is determined by environmental selection forces. On the other hand, the strategic management school which is grounded in the strategic choice model (Child, 1972) emphasizes the importance of managerial decisions and actions in affecting the fate of firms. Hrebiniak and Joyce (1985) reconcile these views by acknowledging the importance of the interaction between the environment and managerial decisions. In general, it is possible to summarize the phenomenon of failure as a function of two factors: environment dependent factors and strategic leadership dependent factors.

To explore the factors associated with company failures in the context of the construction industry, the four quadrants of an "environment/response" matrix developed by Boyle and Desai (1991) were populated with Dun and Bradstreet's U.S. business failure data for the construction industry by Arditi *et al.*, (2000) (see Figure 2). The "environment" is represented on the vertical axis and is divided into two categories, namely the internal environment that represents the events that are under management's control and the external environment that corresponds to the events that are beyond management's control. "Response" is represented on the horizontal axis and is divided into two categories, namely administrative responses that represent the short-term operational activities, and the strategic responses that represent the long-term planning of the firm. This four-cell matrix was adapted to the construction industry by using the factors used in Dun and Bradstreet's annual *Business Failure Reports* (1989-1993). Dun and Bradstreet provide historical data on business activities in the U.S.

It was found that the most important reasons for business failures in the construction industry in the five-year period (1989-1993) were to be found in the internal-administrative and external-strategic quadrants.

These two quadrants represented 68% and 26%, respectively, of all reasons for failure. Whereas internal-administrative issues (budgetary issues and human capital issues) are short-term issues that can be handled by the management, external-strategic issues (macroeconomic issues and natural disasters) are long-term planning issues that are beyond the control of management.

Over 80% of the failures were caused by five factors, namely “insufficient profits” (27%), “industry weakness” (23%), “heavy operating expenses” (18%), “insufficient capital” (8%), and “burdensome institutional debt” (6%). All these factors, except “industry weakness”, are budgetary issues and can therefore be handled by companies that are cognizant of the effects of these factors on their survivability. It appears that, in addition to the strategic leadership factors such as budgetary issues, environmental factors, particularly “industry weakness” (23%), that are beyond a company’s sphere of immediate action, are among the most important determinants of business failure in the construction industry. This finding should however be interpreted in the light of the fact that the cause/effect relationship between environmental and strategic leadership factors is not well established.

The study indicated that budgetary and macroeconomic issues represent 83% of the reasons for construction company failures implying that firms that take vigorous administrative measures to address budgeting issues, and that react promptly to economic conditions by implementing appropriate strategic policies should be able to avoid failure. On the other hand, issues of adaptability to market conditions and business issues appear to have limited effect on company survivability (6% of the reasons), implying that administrative measures to fend off internal conflicts that originate from reasons beyond management’s control, and long-term strategic decisions to regulate the firm’s adaptation to market conditions can also help prevent failure.

3.2 The Input/Output Model

Systems theory views an organization as a complex set of dynamically intertwined and interconnected elements, including its inputs, processes, outputs, feedback loops, and the environment in which it operates and with which it continuously interacts. The input/output relationship is a dynamic process where the system tends to find a balance between its units and the external environment. In this system, the input is processed, generates the output, and the output feeds the input. These shifting states of the dynamic equilibrium are crucial for survival.

The input/output model postulates that an organization is continuously involved in transforming inputs into outputs. Koksai and Arditi (2004a) proposed an input/output model that assumes that “business failure” is the output of long and involved processes composed of three components: *determinants*, *symptoms*, and *outcomes* (see Figure 3). In this model, it is argued that organizational and environmental factors are the *determinants* of failure, which solely or jointly affect the performance of the organization. For example, any decline in demand, an economic crisis or recession is conducive to industry weakness, which may in turn affect an organization’s profits. Lack of business knowledge and inadequate managerial experience may increase operational expenses, create conflict within the organization, and also hurt the competitiveness of the organization. The input/output model enables managers to modify the organizational characteristics of the company and to adjust to environmental conditions by monitoring the positive or negative changes in the performance of the organization. On the other hand, *symptoms* such as “insufficient profits,” “heavy operating expenses” and “burdensome institutional debt” are indicators of failure. The *symptoms* are driven by *determinants*, while *outcomes* (survival or failure) are driven by *symptoms*. The *symptoms* provide an opportunity for managers to detect the early stages of failure and to improve the performance of the organization by making use of the feedback loop.

Environment	Internal: events under management control	<p>CELL I</p> <p style="text-align: right;">Weighted (%) Occurrence</p> <p>BUDGETARY ISSUES</p> <p>Insufficient profits 26.71</p> <p>Heavy operating expenses 17.80</p> <p>Insufficient capital 8.29</p> <p>Burdensome institutional debt 5.93</p> <p>Receivable difficulties 1.46</p> <p>HUMAN/ ORGANIZATIONAL CAPITAL ISSUES</p> <p>Lack of business knowledge ... 3.89</p> <p>Lack of managerial experience 0.91</p> <p>Fraud 0.85</p> <p>Lack of line experience 0.68</p> <p>Lack of commitment 0.62</p> <p>Poor working habits 0.59</p> <p style="text-align: right;">TOTAL: 67.73</p>	<p>CELL II</p> <p style="text-align: right;">Weighted (%) Occurrence</p> <p>ISSUES OF ADAPTATION TO MARKET CONDITIONS</p> <p>Inadequate sales 2.20</p> <p>Not competitive 0.29</p> <p>Overexpansion 0.15</p> <p style="text-align: right;">TOTAL: 2.64</p>
	External: events not under management control	<p>CELL III</p> <p style="text-align: right;">Weighted (%) Occurrence</p> <p>BUSINESS ISSUES</p> <p>Business conflicts 2.43</p> <p>Family problems 1.16</p> <p style="text-align: right;">TOTAL: 3.59</p>	<p>CELL IV</p> <p style="text-align: right;">Weighted (%) Occurrence</p> <p>MACROECONOMIC ISSUES</p> <p>Industry weakness 22.73</p> <p>Poor growth prospect 0.28</p> <p>High interest rates 0.06</p> <p>NATURAL FACTORS</p> <p>Disaster 2.94</p> <p style="text-align: right;">TOTAL: 26.01</p>
		<i>Administrative</i> systems and procedures	Strategic long term planning
Response			

Figure 2: Environment/Response Matrix Distribution

The *determinants* and *symptoms* of the input/output model proposed in this study were formulated by making use of Dun and Bradstreet’s failure factors, as seen in Figure 3.

It was found that environmental factors have a major influence on performance-related factors with 61% compared to organizational factors that have an effect of 39%. Furthermore, “industry weakness” accounted for 83% of environmental factors and constituted the major contributor in this category. On the other hand, “insufficient capital” appeared to be the leading factor with 47% followed by “lack of business knowledge” with 21% of organizational factors. It is important to emphasize that organizational factors that account for only 39% of the determinants of failure carry special significance as these factors can be adjusted by company managers -feedback loop- whereas the managers have no control over environmental factors that constitute the remaining 61% of the determinants.

Symptoms of failure on the other hand are composed of performance-related factors and are the direct driving forces of failure. As expected, “insufficient profits” (46%), “heavy operating expenses” (33%), and “burdensome institutional debt” (10%) appear to be the major factors in this category.

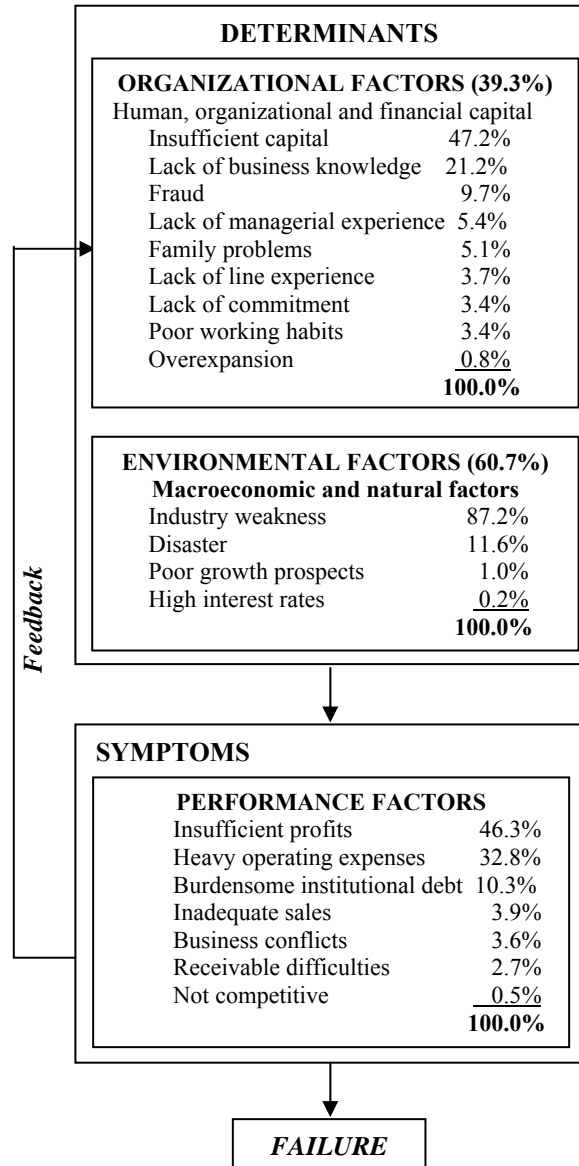


Figure 3: Input/Output Model Distribution

Research studies (e.g., McKinley 1993, Weitzel and Jonsson 1989, Greenhalgh, 1983) indicate that chances of survival increase if decline trends are observed at their early stages. The input/output model enables the company executive to watch for the most common symptoms of failure and to make the necessary modifications in the related organizational determinants in the light of the prevailing environmental conditions. The feedback loop allows the construction executive to take action against the early signs of failure.

4. Predicting Company Decline

Encouraged by the input/output model that promises construction company executives the possibility of turning around their company in case they are able to detect symptoms of failure, a more sophisticated

model was developed by Koksai and Arditi (2004b) to determine whether a company is healthy, whether decline is setting in, or whether decline has reached an advanced stage (see Figure 4). This was a statistical model that was developed by making use of non-financial data collected from construction companies that have filed bankruptcy under Chapter 11 and construction companies that have been functioning without bankruptcy protection.

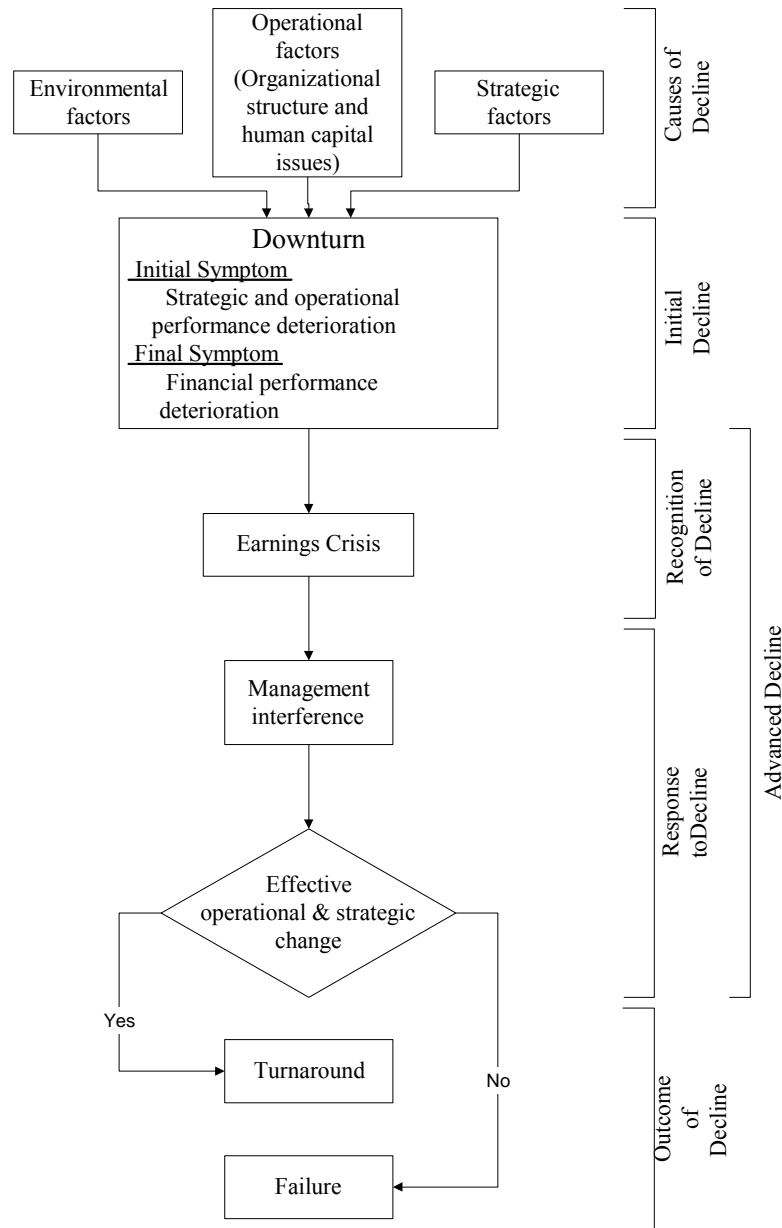


Figure 4: Construction Company Decline Model

A company profile survey administered to 11 bankrupt and 41 non-bankrupt companies provided information about 21 organizational, human capital, and strategic posture characteristics of construction

companies. Factor analysis was used to reduce the number of variables. Factor analysis reduced the original 21 characteristics into three factors that make use of only 11 characteristics.

- Competition based on innovation
 - Activating competitive strategy
 - Defining competitive advantage
 - Adaptation to advanced management practices
 - Adaptation to advanced construction technologies
- Organizational strategy
 - Absence of standardization
 - Defining the scope of the company
 - Diversification of the production markets
 - Absence of specialization
- Managers' qualifications
 - Level of business knowledge
 - Level of work experience
 - Level of managerial expertise

The factors obtained by performing factor analysis were regressed against decline ratings using Multinomial Logistic Regression (MLR). This research demonstrated that non-financial aspects, i.e., organization structure, human capital issues, and strategic posture are important in assessing the condition of a company vis-à-vis decline/failure. If a company executive wishes to assess the condition of his/her company, this assessment can be done by simply rating the strength of as few as 11 characteristics associated with the company. These 11 ratings can then be plugged into the logit functions which in turn yield the probabilities of the company being in any one of the three states of “no-decline”, “initial decline”, and “advanced decline”.

The research study showed that it is extremely difficult to collect information from bankrupt companies as these companies are mostly “inactive.” Also, the executives of the “active” bankrupt companies found it unpleasant and were reluctant to talk about their failure.

This study into detecting the onset of business decline/failure is of relevance to industry practitioners because by making use of this model, construction company executives who detect signs of decline before the advent of a financial crisis should be able to take the necessary measures in good time to initiate a successful turnaround.

5. Protecting Owner against General Contractor Default

Given the research presented in the preceding sections, it is clear that contractor default may be a serious problem in the construction industry. Even though some of the research is able to explain the reasons for the decline and eventual failure of a construction company, and even though measures can be taken to turn around companies that are on the verge of failure, it looks like this problem is not generally recognized by the parties early enough. Consequently, measures to generate a turnaround cannot be taken, forcing construction owners to seek protection against this kind of event.

The objective of the study reported here was to provide owners with a decision-making mechanism that will free them from automatically taking the typical “transfer the risk to a surety” option and will allow

them to make intelligent and economical decisions that include retaining or avoiding the risk of contractor default (Al-Sobiei *et al.*, 2004, 2005). An artificial neural network (ANN) model was trained by using a neural strategy and a genetic strategy to predict the risk of contractor default.

Data were extracted from files stored by a major surety company in the U.S. The files contained information about bonded contractors, some of which had defaulted while others had not in a period of eight years. The data collected represented 78 “defaulted” and 102 “non-defaulted” contractors.

The variables used in this model were extracted from the reports that underwriters in the surety company utilize in their decision of the limit of the bond. Some of the inputs are expressed either in dollar amounts or financial rates provided by Dun and Bradstreet.

Once the nets were trained to predict contractor default by using the neural and genetic training strategies, they were then tested by means of data collected from 4 defaulted and 4 non-defaulted contractors that had been put aside for this purpose. According to the results, the predictions coincided with the actual occurrences in six out of eight cases (75%) when the neural training strategy was used to predict default, and seven out of eight cases (88%) when the genetic training strategy was used.

Risk allocation is the process of determining how and to what extent the risk should be shared. A flowchart is presented in Figure 4 to illustrate how to find the most suitable method of risk management for situations where contractor default is the risk in question. At the beginning, the likelihood of contractor default is predicted using the genetic training strategy since the genetic training strategy generated a higher rate of prediction than the neural training strategy. A good understanding of the organization’s risk taking behavior is also essential for making a sound decision. It has been generally accepted by risk management researchers that the risk behavior of organizations falls into three general classifications (Willenbrock, 1973):

- *Risk seeking* organizations have a preference for risk. For these organizations, even a large loss could not make things much worse than they are now, whereas a large profit could very substantially improve the situation.
- *Risk neutral* organizations are well supplied with working capital, believe in self insurance against moderate risks and base their action on expected profits.
- *Risk averse* organizations are conservative and have a preference for certainty. These organizations do not take chances unless the likelihood that the outcome will be positive is significantly high.

Once the likelihood of contractor default is predicted using the genetic training strategy and the owner’s risk behavior is established, the owner can make a decision to retain, transfer, or avoid the risk of contractor default. It should be noted in the highlighted parts of Figure 5 that in addition to the traditionally used alternative of transferring the risk of contractor default to a surety, the owner also has the options of retaining or avoiding this risk, albeit in rare circumstances (i.e., the northeast and southwest corners of the decision matrix).

While avoiding the risk of contractor default entails not engaging the contractor in question, retaining the risk involves a willingness to foot the bill if contractor default occurs. In addition to the usual contingency allowance that the owner generally allocates for risks other than contractor default, the owner should budget an amount equal to the expected loss associated with default. An analysis of the data collected in this study indicated that the losses incurred in the case of contractor default ranged between 0.02% and 15.13% of the contract value with an average of 2.14% weighted for project size. Depending on the characteristics of the project in question, the owner is advised to budget a contingency fund of up to 15% of the contract value.

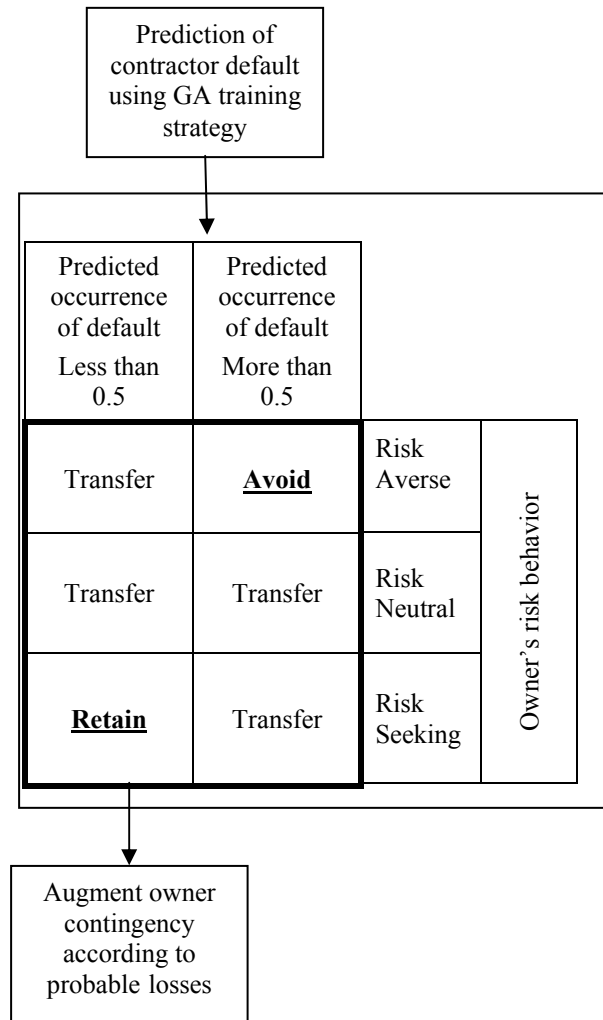


Figure 5: Owner's Risk Allocation Model

6. Protecting General Contractor against Subcontractor Default

A subcontractor is a construction firm that contracts with a general contractor to perform some aspect of the general contractor's work. On many projects, especially building projects, it is common for 80-90% of the work to be performed by subcontractors (Hinze and Tracey, 1994). Regardless of the general contractor's skills, portions of virtually every project will be subcontracted to firms that possess specialized skills because the subcontracting system has been proven to be efficient and economical. However, even though a large portion of a construction project is usually performed by subcontractors, the issues concerning subcontracting practice are seldom acknowledged.

Similar to a construction owner running the risk of general contractor default, a general contractor runs the risk that subcontractors will not be able to complete the project on schedule, within budget and in compliance with plans and specifications. As mentioned in the preceding section, a surety bond is one of the leading financial instruments used to guarantee the completion of an obligation. If the principal fails to perform, the obligee can turn to the bonding company, which must step in and, on behalf of the

principal, accomplish the work according to contract terms (Russell, 2000). Retainage is also used as a measure to remedy the actions of the misbehaving subcontractor. Finally, insurance policies are used as a mechanism to manage the financial risks present in the business.

A study conducted by Arditi and Chotibhongs (2005) investigated issues that included, among other things, the management of the risk of subcontractor default through subcontractor bonding, Retainage and insurance. Three surveys were conducted in order to get information from the top 450 subcontractors, 300 general contractors, and 250 owners in the U.S. The rates of response were 28%, 22% and 13% for specialty contractors, general contractors and owner firms, respectively. Tests of significance were used to determine whether the means of the findings of the samples differ significantly from each other.

6.1 Bonding of the Subcontractor

The general contractor is responsible for the performance of the subcontractors. The general contractor becomes liable if a subcontractor fails to pay for materials, labor, or sub-subcontractors since the general contractor is obligated to complete the project free and clear of all liens. The risk the general contractor shoulders includes the possibility of subcontractor default – something over which the general contractor has limited control. Protection is afforded to the general contractor by requiring the subcontractor to provide the general contractor with a payment and performance bond (Clough *et al.*, 2005; Hinze, 1993). Litigation that might arise would then be in the hands of the sureties (Hinze, 1993).

How often subcontractors are required to submit performance and payment bonds before signing an agreement with a general contractor was measured on a 0-3 scoring system where 0 represents “never”, 1 “sometimes” and 2 “often” and 3 “always”. The average frequencies were 1.25, 1.20 and 1.24 for the responding subcontractors, general contractors and owners, respectively. The differences in the average frequencies between the three groups were not statistically significant at $\alpha = 0.05$. The reason why subcontractor bonds are “sometimes” required by general contractors is because subcontractor bonds are normally required only on large construction projects or on projects that involve high default risks particularly in locations where the general contractor is not familiar with local subcontractors and conditions. This result is in agreement with the study conducted by Hinze (1993) that found that 68% of subcontractors were infrequently required to provide bonds.

6.2 Retainage Withheld by General Contractor

Many construction contracts, especially those that involve competitive bidding, provide that the owner will retain a certain percentage of the progress payments to allow for the correction of faulty or missing work. Usually, the accumulated retainage remains in the possession of the owner until the project is completed and final payment is made, with the owner paying the contractor no interest on these funds. In turn, general contractors often withhold retainage from the payments they make to their subcontractors.

How often do general contractors withhold retainage from their subcontractors? The average frequencies were 2.50, 2.56 and 2.30, between “often” and “always” for the responding subcontractors, general contractors and owners, respectively. The differences between the frequencies were not statistically significant when tested at $\alpha = 0.05$. It was also found that the retainage withheld from subcontractor payments by general contractors is not higher than what is withheld by owners from general contractors’ payments as previously reported by Hinze (1993). It appears that general contractors are “often” forced to retain a similar percentage from the progress payments they make to their subcontractors because most contracts allow owners to retain a certain percentage of the progress payments to their general contractors.

Most subcontractors, general contractors and owners do not regard the issue of retainage to be a major problem. But more than half of the subcontractors, general contractors and owners indicated that the magnitude of the retainage is an important factor to be considered before entering into an agreement with the general contractor. These subcontractors indicated that retainage can produce real cash flow problems, resulting in substantial borrowing at sometimes a hefty interest rate. This results in higher construction costs for owners (Clough *et al.*, 2005).

The American Subcontractor Association (ASA) contends that retainage is nothing more than a means for general contractors and owners to pad their cash flow. Some subcontractors and general contractors, but no owners are of the opinion that owners should stop retaining money from general contractors eliminating the need of general contractors to withhold retainage from their subcontractors, presumably because retainage is perceived by owners to be a means to guarantee good quality and timely completion of subcontracted work.

6.3 Risk Transfer through Insurance

In an era when lawsuits are common practice, owners, contractors, subcontractors and design professionals cannot afford to assume risks that could potentially impair the longevity of their business (Russell, 1990). An array of basic insurance policies is needed to cover the different risks that may be encountered. Ideally, the policies fit together to provide a web of coverage protecting both the project and the parties from loss. But while maintaining adequate coverage to protect themselves, the parties involved also have to be prudent when specifying required insurance policies and avoid selecting unnecessary or excessive coverage and consequently increasing the project's cost.

In the construction industry, risk is commonly transferred to the subcontractor. The least balanced approach for a subcontractor is "broad form" indemnity, which entirely relieves the general contractor and/or owner from covering losses related to the subcontractor's performance of work, regardless of the cause or type of risk. Another risk, which is independent of but can have the same effect as indemnity provisions, is the additional insured endorsement. If the subcontractor agrees to an additional insured endorsement, other parties (the owner and/or general contractor) are named as insured under the subcontractor's commercial general liability policy. A third method of risk transfer that makes the subcontractor responsible for losses controlled by other parties is the waiver of subrogation. The general contractor and/or owner may ask the subcontractor to sign this waiver, which protects the subcontractor's insurance carrier from making any claim to recover funds from the general contractor.

What can be done to improve bonding/insurance practice relative to subcontractors? The opinions of the respondents are shown in Figure 6. The percentage of general contractors who stated that the current bonding/insurance practice is acceptable was very high (91%) probably because in the current practice, the general contractor is well protected. On the other hand, only few subcontractors found the current practice acceptable, probably because they felt that most of the risk is generally shifted to subcontractors.

Many owners and subcontractors suggested that educating the subcontractor's staff about the language used in the subcontract was another major way to improve subcontractor bonding/insurance practice. The respondents' contention was that very often, the contract clauses concerning insurance are not well understood by subcontractors at the time the agreement is signed. Subcontractors find out about the consequences of an insurance policy only after it is too late. The review of the contract language thoroughly by a professional before the agreement is signed should prevent future surprises.

Almost none of the respondents believed that subcontractor bonding causes problems. This appears to be an accepted practice in larger projects. The fact that subcontractors, general contractors and owners agree on this issue may be interpreted to mean that subcontractor bonding contributes to a fair distribution of

risks in such projects. Indeed, the premiums paid by subcontractors and contractors to surety companies to obtain their respective contract bonds are not a burden to them since these premiums are part of their overhead and are eventually paid by the owner. Similarly, owners do indeed end up paying for the transfer of this risk to the surety company, but in return they get a risk-free project.

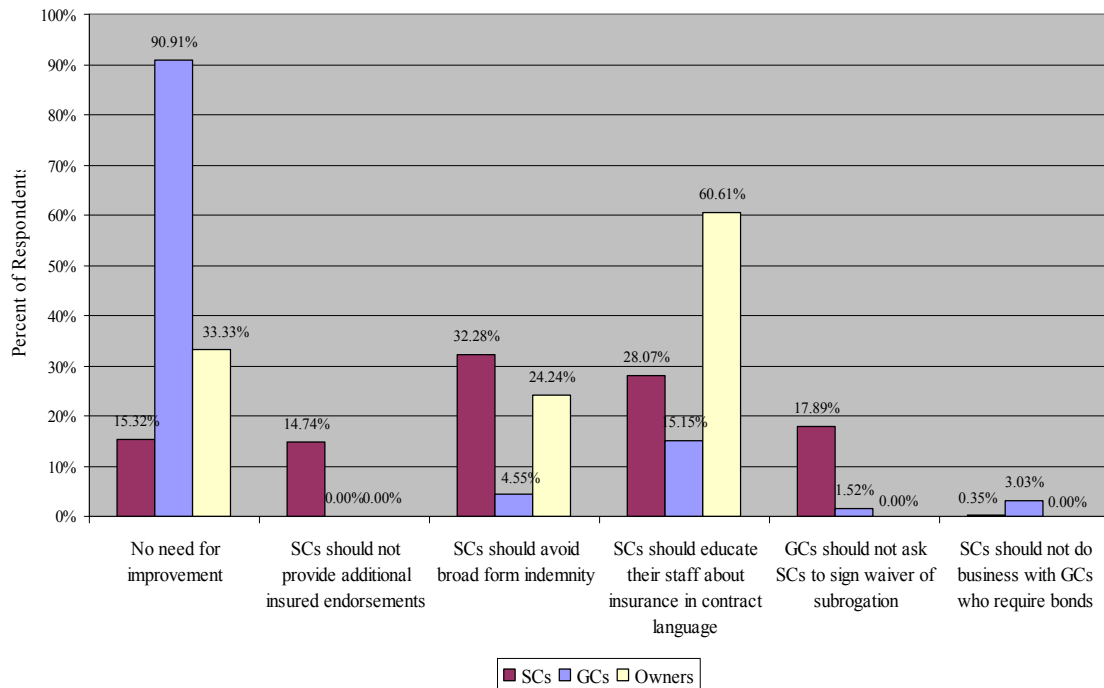


Figure 6: Ways to Improve Subcontractor Bonding/Insurance Practice

7. Conclusion

The construction process involves a large number of risks, one of the most important of which is the risk of contractor default. Contractors need to have a good understanding of why construction companies fail and of typical failure patterns. Contractors need to be able to predict the state of their company. If decline is observed, contractors should be able to take corrective action early enough in order to turn the company around. Observing only the usual financial indicators for signs of failure may not allow the contractor enough time to take corrective action.

A series of research studies were undertaken in the ten-year period 1995-2005 to investigate various aspects of this problem. The overall findings indicate that:

- Construction company failure is age-dependent
 - Newness and smallness contribute to failure
 - The risk of failure is greater in the adolescence period (3-4 years into the life a company)
- Most causes of failure can be prevented by management action
- By the time financial symptoms are apparent, it may be too late to turn the company around
- It is possible to predict the state of decline by using non-financial data
- The owner can use intelligent/economic protection against contractor default
- Subcontractor default is an important part of the risk equation

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Keynote Speech 2

Exploring the Issues for Innovation Platforms for the Future of Construction Industry: Scenario Planning Approach

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Abstract

The construction industry needs to be responsive to the economic, social, and technological challenges that the world is facing in order to maintain its competitiveness. Innovation is accepted to be one of the key drivers of economic growth and competitiveness and so business and policy should be aligned to ensure the success of innovation. To this end, innovation platforms are a new way of working for government and business that enable the integration of a range of technologies and better coordination of policy and procurement. To be effective, an innovation platform in construction would need to be able to respond to the diverse needs of the sector and the diverse ways in which innovation can happen. Since the needs of the industry are continuously changing, identifying possible futures is a must to inform the strategic planning and programme of work for such a platform. Scenario techniques have been used as a strategic planning tool for years in order to develop a future vision and a strategic action plan. This paper proposes the use of a scenario planning approach as an enabler to develop a strategic action plan for the implementation of innovation platforms in order to realise a preferred construction future. In this respect, the need for innovation platforms and their roles/functions will be discussed and how scenario planning approach can be utilized to help develop a construction vision will be explained. Finally, the critical elements of innovation platforms within such a vision will be explored.

Keywords

Innovation platform, Construction vision, Scenario planning, Prospective thinking

1. Introduction

Construction is a vital sector contributing significantly to the economies of all countries. The construction industry should be dynamic so as to respond to the changes that the world is constantly facing. In addition to the social, economic, and technologic challenges affecting all industries, the opportunities and problems in construction will be different from those of today. The needs and demands of clients will not

remain the same, while construction materials and methods will transform the way the built environment is designed, built and maintained. The ability of the construction industry to maintain its effectiveness and competitiveness lies in its adaptability to the possible scenarios in the future. To help shape this future, a construction vision should be developed including clear objectives and strategies in order to meet the requirements of the future world.

Innovation is regarded as one of the key factors contributing to national economic growth, competitiveness, and quality of life through the creation and adoption of new knowledge to improve the value of products, processes, and services. Being a project-based and fragmented industry, the patterns of innovation in construction are different in many ways from those of others. As Barrett *et al.*, (2001) have suggested, specific research into innovation in construction must be undertaken and all generic innovation research be “envisioned, embedded and evaluated in a construction context to form a robust body of construction innovation knowledge in its own right”. Innovation can be a key source of competitive advantage for construction companies, offering the means through which a firm can achieve a client’s objectives in a specific project, or its own objectives over a range of projects (Slaughter, 2000).

In this paper, an innovation platform, that better links the resources and talent of higher education institutions to industry, is suggested to respond to the diverse needs of the construction sector and the ways in which innovation can happen. Innovation platforms are an efficient way of engaging all stakeholders in the innovation process. The main aim is to maximize the benefits that can be realized through innovation. Such a platform can be an effective solution to enhance the innovation capability at the national level. However, the establishment and management of innovation platforms should be in line with the overall construction vision. A scenario planning approach is proposed to identify the critical elements for the future of construction and to develop a strategic action plan for the implementation of innovation platforms in order to realise a preferred construction future. Scenario planning is a key technique used by futurists to develop future models in order to help this process and to develop strategic action plans and policies or to create a vision for the future (Erdogan *et al.*, 2009). In this respect, the need for innovation platforms and their roles/functions will be discussed and how scenario planning could help to develop a construction vision and how innovation platforms should be established and managed in order to realise this vision will be investigated.

2. Innovation Platform for Construction

The innovation platform suggested in this paper constitutes a loose coupled structure involving industry and academia, which would undertake a range of activities, catering for organisations with different levels of experience and capabilities. The model recognises the need to not only provide solutions and new ideas, but also to stimulate demand and develop capability (Abbott *et al.*, 2008). In this context, the scenario planning approach is proposed as a means of formulating strategic plans to effectively establish and operate innovation platforms and identifying the roles and responsibilities of different parties involved in this process. The following paragraphs discuss the innovation process in construction and the role of innovation platforms.

2.1 Innovation in Construction

Slaughter and Shimizu (2000) defined innovation as “the actual use of nontrivial improvements in products, processes or system that are actually used and are novel to the organisation developing and/or using them”. As DTI (2003) put it forward:

“The creation and commercialization of new knowledge is a final and crucial source of dynamic improvements in productivity. For advanced economies, innovation is a matter of pushing the world frontier of knowledge. For developing countries technology assimilation is the central challenge”.

Innovation has a number of outcomes, including (Barrett and Sexton, 1998):

- the renewal and enlargement of products and services, and their associated market,
- new methods of production, supply and distribution, and
- new organisational and work forms and practices.

Being project-based, construction is often perceived as being among the low innovative industries. Commentators have labelled the sector as being ‘extremely conservative’ (Rosenberg, 1982), ‘low tech’ (Reichstein *et al.*, 2005) and ‘an industry of the old type (Landes, 1969). There are many characteristics of the industry that are put forward as the ‘cause’ of this lack of dynamism and innovation. According to Barrett *et al.*, (2007) these characterisations can be distilled into three strands. Firstly, the temporary project-based nature of the industry is seen as constraining innovation (Gann and Salter, 2000). Secondly, the structure of the industry with its preponderance of small firms employing less than five people gives rise to an associated limited capacity to innovate (Sexton and Barrett, 2003). Lastly, the adversarial nature of the industry with associated short-termism and opportunism does not encourage long term solutions.

However, construction is a very diverse sector and there is not one single way in which innovation occurs. Much of this reputation is undeserved as current measures of innovation do not reflect the way in which innovation occurs in the sector (Barrett *et al.*, 2007). In addition, the organizational context of construction innovations differs significantly from a great portion of manufacturing innovations (Slaughter, 1998). According to Lansley (1996) the occurrence of innovation within the construction industry is often characterised by the widespread adoption of new practices as a result of advances in technological and business processes. Innovative activities and effects of innovation depend extensively on the why innovation takes place (drivers) and who innovates (actors) as well as the external environment the innovation takes place.

2.2 The Role of Innovation Platforms

An economy’s rate of innovation depends on a range of activities and the links between them. Companies may take the lead, but do not innovate in isolation. Most innovations involve a multitude of organizations. In order to manage innovation process at the national level, a systems view should be adopted. The National Systems of Innovation (NSI) approach studies innovating firms in the context of the external institutions, government policies, competitors, suppliers, customers, value systems, and social and cultural practices that affect their operation (OECD and Eurostat, 2005). NSI provides a framework in which the whole innovation process can be analyzed in detail.

The Sainsbury Report (Turville, 2007) places innovation activity in the context of an innovation ecosystem within which the *“innovation rate depends on inter-linked activities which include: industrial research; publicly funded basic research; user-driven research; knowledge transfer; institutions governing intellectual property and standards; supply of venture capital; education and training of scientists and engineers; innovation policies of government departments; science and innovation policies of RDAs; and international scientific and technological collaboration”.*

In the national context, the concept of the innovation platform is being adopted by the UK government. Innovation Platforms are being developed nationally by Department for Business Enterprise and Regulatory Reform (BERR). According to BERR, innovation platforms are a new way of working for

government and business that enable the integration of a range of technologies and better coordination of policy and procurement, resulting in a step-change in UK performance. BERR define the key features of innovation platforms as follows (BERR, 2008). Innovation Platforms:

- engage with business and the research community,
- bring together government stakeholders/funders,
- identify the appropriate levers to use,
- seek to align funding streams from separate sources, and
- links research to market through procurement opportunities.

2.3 An Innovation Platform for Construction

The understanding of the nature of innovation in an increasingly service oriented economy has developed to encompass a much wider conception. This wider view accepts that innovation differs from sector to sector and from organization to organization. To respond to the modern business environment, companies are increasingly looking to more open innovation models, developing and exploiting new ideas in conjunction with a range of partners in a non-linear fashion. Innovation platforms are a new way of working for government and business that enable the integration of a range of technologies and better coordination of policy and procurement. An innovation platform must be responsive to this reality and be capable of playing its part in an overall innovation ecosystem that will change and develop over time.

Despite this desire for more collaboration between industry and academia, there is still much to be done. As pointed out by Gann (2001), universities and firms remain very different in terms of the ways in which they generate and manage knowledge. University research has typically been discipline-based, focusing mainly on long-term research issues for the advancement of knowledge and the training of new generations of researchers. The model below implies a gradual development of capacity and capability for organisations that engage with universities through the platform (Figure 1).

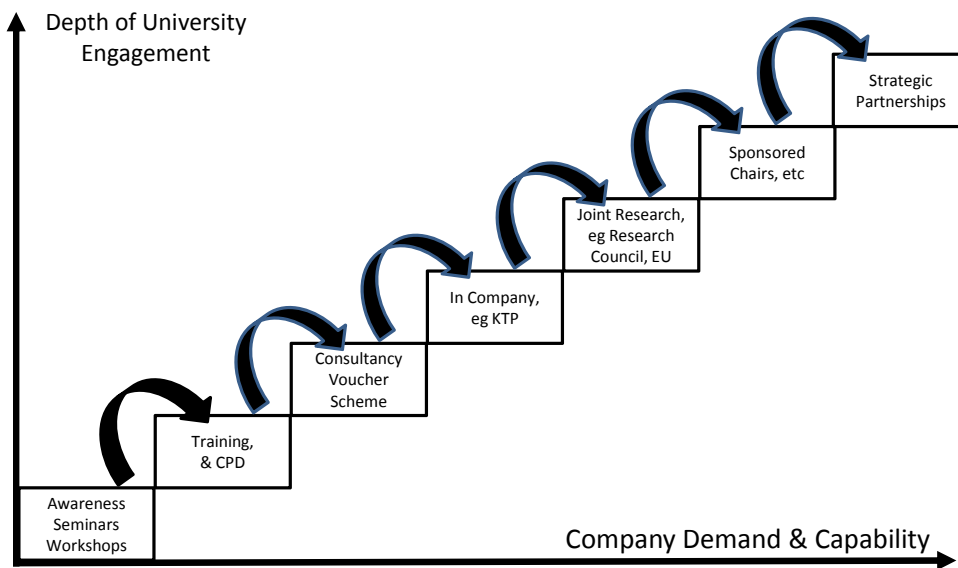


Figure 1: Seven Stage Model for an Innovation Platform (Abbott *et al.*, 2008)

Increasing the demand for university engagement should be the underpinning activity of an innovation platform. Awareness raising, as detailed above, is important. The simplest level of engagement for a company with a university could be attendance at workshops, training or continuous professional development (CPD) accredited activity where such activity already exists. An innovation platform can play a role in co-ordinating and documenting all such activity but also through industrial membership lead the development of more such activity in response to a better understanding of demand. The development and promotion of training in innovation as a discipline in its own right should be considered here. Familiarity and trust, established through awareness raising and training activity, can lead to the better understanding of university capabilities and the consequent identification of a university as a partner in solving pressing business problems. The proposed innovation voucher scheme here could provide a useful demand led system. Other alternatives worthy of consideration in terms of targeted funding would be mini Knowledge Transfer Partnership (KTP, <http://www.ktponline.org.uk/>) schemes. Embedding researchers within companies as part of existing research activity is another method of universities emerging themselves within business contexts and problems. Stages 5-7 assume a higher degree of collaboration based around the mutual development of work and research. Jointly developing and bidding for research projects, particularly under schemes such as the UK Technology Strategy Board would be likely. A portfolio of successful activities at the Stage 5 level can lead to a more formal 'framework' type agreement. In this way, long-term collaboration is agreed with the recognition that the university and companies are strategic partners. The final stage of this process is a culmination of all other stages. Both sides will be seen as key strategic partners in the development of their respective business.

All of the above implies an open system with a loose central co-ordination structure and strengthened regional brand. In this way the innovation platform can support and enhance individual initiative and growth rather than to control and constrain. The roles and responsibilities of the parties involved within the innovation platform should be identified to be able to respond to changes in the external environment, and an action plan should be set based to address different possible future scenarios. The next section introduces and explains the scenario planning approach which will be followed by how to develop strategic action plans for establishing and effectively managing innovation platforms in construction.

3. Scenario Planning

From the earliest times, there has been an interest to know what the future might bring. At the organizational level, anticipating the future is considered as a useful way to align and improve current strategies. This interest has been reflected in future studies, strategic planning, scenario thinking and planning, foresight, and futurology. The term scenario is a fuzzy concept with many different definitions and many different meanings attached to it. According to Porter, a scenario is "*an internally consistent view of what the future might turn out to be- not a forecast, but one possible future outcome*" (Porter, 1985). Selin (2006) defines scenarios as stories describing different but equally plausible futures that are developed using methods that systematically gather perceptions about certainties and uncertainties. According to Godet (1987), scenarios should aim to detect the key variables that emerge from the relationship between the many different factors describing a particular system, especially those relating to the particular actors and their strategies.

Due to its aid to understand the nature and impact of most uncertain and important driving forces affecting our world, scenario planning is considered as a strategic planning tool enabling the development of flexible long-term plans (JISC, 2008). According to Wack (1985), scenario planning is a discipline for rediscovering the original entrepreneurial power of creative foresight in contexts of accelerated change, greater complexity, and genuine uncertainty. Scenario planning does not focus on accurately predicting the future (Hodgkinson and Wright, 2002) but rather is a process that produces a number of possible

futures that are credible and yet uncertain (Brauers and Weber, 1988; Simpson, 1992; Schoemaker, 1995; Schwartz, 1996; van der Heijden *et al.*, 2002).

Scenario building helps (Fahey and Randall, 1998):

- augment understanding by helping to see what possible futures might look like, how they might come about, and why this might happen.
- produce new decisions by forcing fresh considerations to surface.
- reframe existing decisions by providing a new context within which they are taken.
- identify contingent decisions by exploring what an organisation might do if certain circumstances arise.

Scenario planning leads to strategic actions through improving the decision-making process within the companies. Chermack (2004) presented a model that specifically outlines how scenario planning can improve the decision-making process. The model relied on several items to improve decision making: reduced bounded rationality, the consideration of exogenous and endogenous variables, reduced information stickiness, increased knowledge friction, and alternative mental models.

3.1 Development of Scenario Planning

Scenario building has been used in a variety of situations such as European Commission future planning, the global telecommunications industry, East Asian economic emergence, the French iron and steel industry, the US defence industry, new business models, British Airways, Cable and Wireless, ICL, United Distillers and the UK National Health Service (Ringland, 1998). Scenario planning started to be used strategically after the World War II. Herman Kahn, who coined the phrase “thinking about the unthinkable”, is considered as the founder of scenario based planning. After Kahn, further research in the USA on scenario based planning resulted in a number of alternative approaches. These approaches can be categorized under three major groups (Huss and Honton, 1987):

- Intuitive logics-described by Pierre Wack and used in Stanford Research Institute (SRI) International and Shell;
- Trend-Impact Analysis practiced by The Futures Group;
- Cross-Impact Analysis practiced by Center for Futures Research (INTERAX) and Batelle (BASICS).

The second major thrust for scenario planning research has been in France. Here, scenario planning research mainly focused on the ‘scientific and political foundations of future’. In 1950s, Gaston Berger, a French philosopher, founded the Centre d’Etudes Prospectives and developed a scenario approach to long-term planning, which is known as prospective thinking or La Prospective. In the mid-1970’s, the French School gained a new member, Michel Godet, who developed a mathematical and computer-based probabilistic approach to scenario development and classified problem solving methods (some were developed by himself) for different stages of the prospective scenario planning approach (Godet and Roubelat, 1996; Bradfield *et al.*, 2005). The prospective approach generally focuses on an integrated scenario planning and strategic planning approach. Figure 2 shows the complete process of this integrated approach proposed by Godet (2000). This research follows a modified version of the prospective approach.

3.2 Scenario Planning Approach to Develop a Vision for Construction Industry

As discussed in the previous sections, a seven-stage model was suggested for developing an innovation platform in construction (Abbott *et al.*, 2008). In order to explore the related issues of the innovation

platform and to accomplish the objectives of the seven-stage model, proper strategies are needed. In this respect, scenario planning approach will be followed to identify the possible futures of construction and to develop a vision for the construction industry. In order to realize this vision, strategies will be developed and innovation platforms will play a key role whilst carrying out the strategic action plans. The scenario planning approach recommended in this research is the same approach followed for the ICT Vision Development, a research project carried out in the Salford Centre for Research and Innovation (SCRI) in University of Salford. The aim of the project was to anticipating the possible futures the construction industry and construction IT may face and to develop a preferred construction IT vision considering the forces driving the future (Erdogan *et al.*, 2009). It followed a modified prospective scenario planning approach according to the aims of the research.

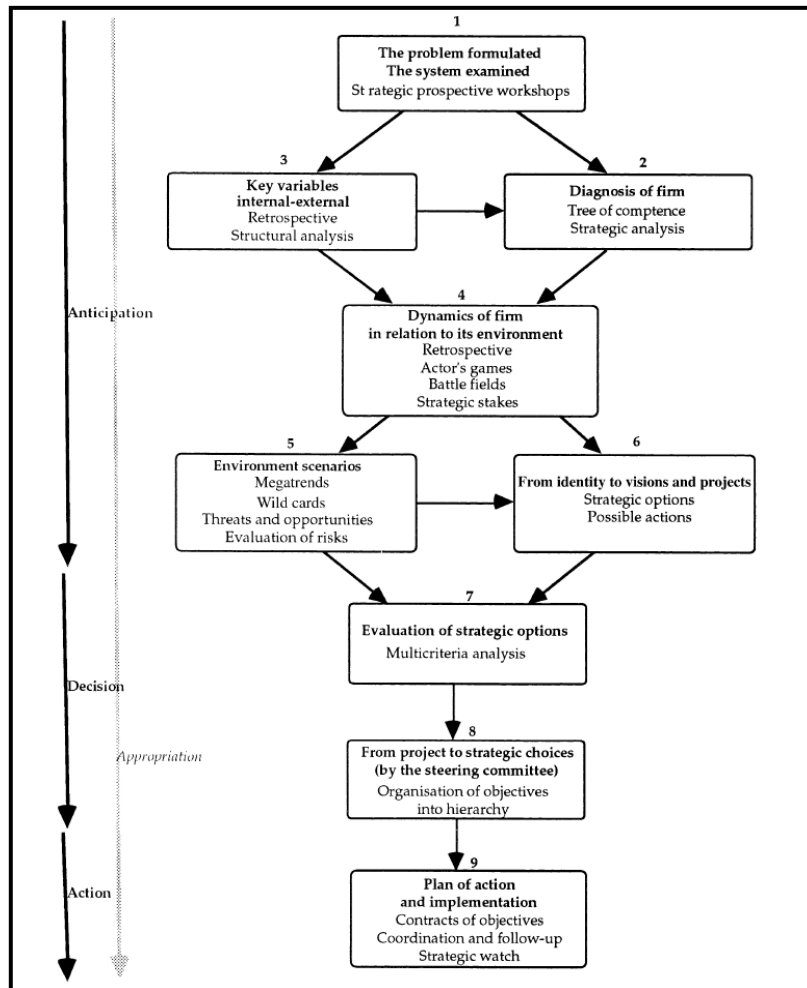


Figure 2: Godet's Scenario Planning: Complete Process (Godet, 2000)

For the innovation platforms research, it was decided to follow the same steps as the ICT vision planning research carrying out some modifications related to innovation platforms. Through these steps, it is aimed to identify possible futures, to formulate strategies through scenarios and to define the roles and missions of relevant parties within the innovation system in order to realize the construction vision. These steps are shown in Figure 3 and explained below.

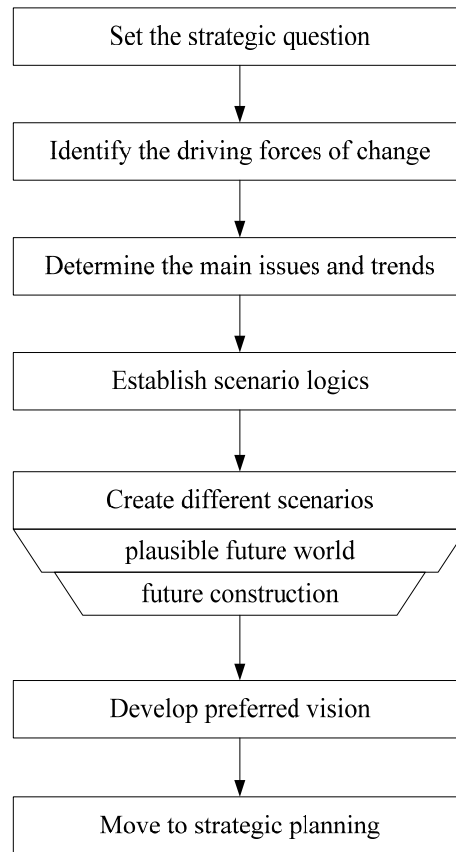


Figure 3: Scenario Planning Approach for Developing a Vision for Construction Industry (adapted from Erdogan *et al.*, 2009)

1. Set the strategic question

The first stage aims to identify the problem posed and define the system under examination. The strategic question in this study is determined as “what will be the possible futures construction industry might face and how should innovation platforms be shaped to achieve a preferred vision whilst being prepared for the possible issues and events that might affect the future”. Such a platform should be capable of addressing the changes in the global environment as well as the construction industry in order to effectively manage innovation. After the strategic question is defined, the research proceeds to the other stages through the scenario planning workshops and ongoing interviews with key actors. Starting from the second step, some recommendations are provided how to achieve the objective of each step.

2. Identify the driving forces of change

The driving forces of change can be identified by continuous monitoring through ‘horizon’ or ‘environmental’ scanning; in-depth interviews with acknowledged experts; targeted questionnaire surveys; and brainstorming workshops at the start of the prospective process (Kelly *et al.*, 2004). In the proposed study, the driving forces will be determined in a number of scenario planning brainstorming workshops, which will have participants from academia and industry. The driving forces will be categorized according to DEGEST categorization (Demographic, Economic, Governance, Environmental, Societal and Technological) and their interrelationships will be investigated in the workshops.

3. Determine the main issues and trends

This stage will focus on the main issues and trends that might shape the construction industry's future considering the drivers of change identified in the previous stage. The workshop participants will be asked to identify the main issues and trends and the associated impacts and uncertainties. This will be followed by the clustering process where the forces, issues and trends are grouped into a number of high level concepts. Clustering is a critical part of this stage since it informs the scenario logics.

4. Establish scenario logics

Scenario logics refer to a logical rationale and structure for the scenarios enabled by intuition, insight and creativity (Ratcliffe, 2000). With this stage, the themes for a scenario are defined. The scenario logics might be articulated by laying-out in simple narrative form, or by using the 2x2 matrix approach, or by depicting the logics and their interactions or relationships diagrammatically showing causal connections (Ratcliffe and Sirr, 2003). The scenario logics will be decided according to the results obtained in the previous stages and the number of scenarios will be restricted to a maximum of five or six.

5. Create different scenarios

Scenarios can be created in many different ways depending on the circumstances, timescales, organizational or sectoral cultures, facilitation methods and available resources. Regardless of the method of generation, each scenario should have four characteristics (Vanston *et al.*, 1977): plausibility; self-consistency; inclusion of all critical, relevant factors; and similarity to other scenarios in form and scope.

Scenarios will initially be developed by the participants attending the brainstorming workshop. Each scenario will have an approximate timeline, early indicators of change and a memorable title describing the essence of the scenario. The scenarios will start from the global view and will present the images of the future world. They will then focus on the construction industry and will imagine how the future world will shape the construction industry. The scenarios will then be revised during the subsequent workshops.

6. Develop a preferred vision in construction

This stage aims to develop a single preferred future for construction. It is based on the principle that the future can be influenced if we know what we want it to be. The previous exercises to identify the drivers, trends and issues and their relationships and to develop scenarios enable thinking outside the box and will initiate the development of a preferred construction vision.

7. Move to strategic planning

This stage will focus on how innovation platforms can be used to achieve the preferred vision defined in the preferred stage. For this reason, the barriers and enablers of the construction vision will be identified considering the innovation perspective, strategic policy and action areas for the innovation platforms will be determined. In addition, the roles and missions of relevant parties within the innovation system will be defined in order to realize the construction vision. The mind map developed for the issues related to an innovation platform will be used as a basis for the action plans. This mind map is shown in Figure 4. The framework of the strategic plan will be developed during the first brainstorming workshop and will be detailed during the follow-up workshops, where action plans will be formulated for each issue in order to achieve the preferred vision.

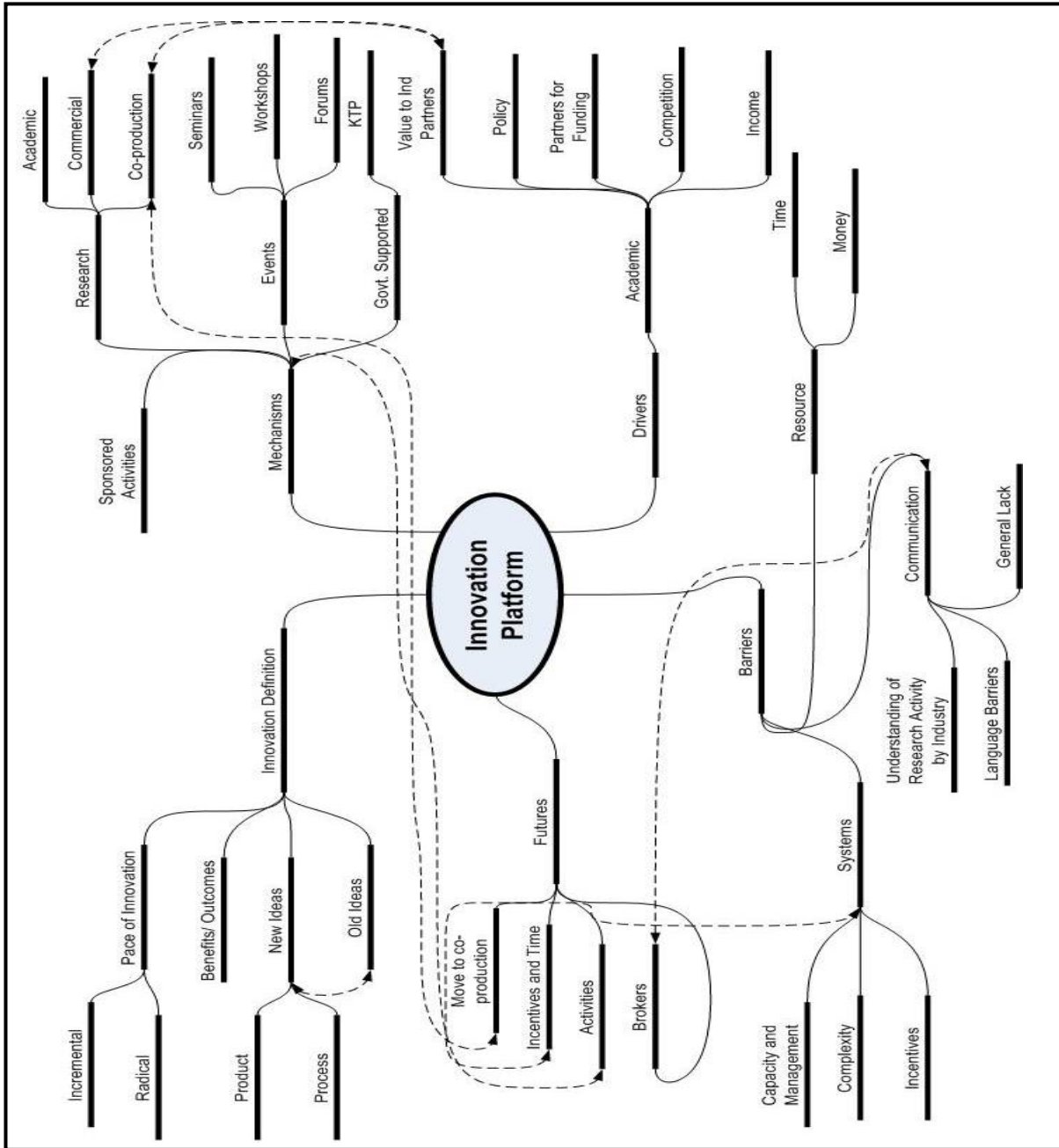


Figure 4: Mind Map Classifying Issues Related to an Innovation Platform for Construction (Abbott et al., 2008)

4. Conclusions

Given the constant changes in the business environment, the competitiveness of the construction industry is highly dependent on its dynamism and adaptability to possible scenarios in the future. Due to its contribution to performance at the firm, sector and national levels, innovation has become a central issue for all industries and countries. Although construction is often perceived as being among the low

innovative sectors, effective management of innovation is essential to create value for construction companies. Within the context of this study, innovation platforms are proposed to be an effective way of managing the innovation process by maximizing the stakeholder involvement. Innovation platforms enable the integration of a range of technologies and better coordination of policy and procurement. In this paper, the conceptual framework for an innovation platform in construction is presented, major issues related to this model are identified, and necessary steps for implementing an effective platform are determined. However, the establishment and management of innovation platforms should be in line with an overall construction vision that would respond to the emerging needs of the world and construction industry in the future. A scenario planning approach is proposed to identify the critical elements and to develop a strategic action plan for the implementation of innovation platforms in order to be prepared for what future might bring to construction industry and to realise a preferred construction future.

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The paper number and page numbers refer to the complete paper present in the attached CD (back cover). The CD contains full version of the papers included in the proceedings

1. Cost Engineering and Financial Issues

1.1 Cost and Financial Management

Paper 3, Page: 27-32

The Modelling Building Life Cycle Costs with Software Support

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Abstract: The construction industry has been traditionally beset with a number of potential problems, such as the lack of co-operation, mutual trust and effective communication, resulting in adverse overall project performance. To achieve better value for money during the project delivery process, guaranteed maximum price (GMP) and target cost contracting (TCC) with a gain-share/pain-share arrangement have been successfully applied in the United Kingdom and Australia. However, there still exhibits a lack of research evidence to evaluate the levels of success and lessons learned from those GMP/TCC projects. Based on a series of in-depth interviews on the perceptions of experienced industrial practitioners, this paper aims to explore the key characteristics of GMP/TCC including the underlying motives, perceived benefits and potential difficulties of implementing this form of project procurement in the Hong Kong construction industry. The research findings provide some useful insights to assist key project stakeholders in maximizing the benefits derived from and minimizing the detriments brought about by potential difficulties in implementing GMP/TCC concepts.

Paper 4, Page: 33-40

An Artificial Neural Network for the Pre-Estimation of Construction Costs for Electrical and Mechanical Installations on Road Tunnels

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Abstract: Electrical and mechanical (E&M) installations on road tunnels consist of several sub-systems such as ventilation, lighting, electrical power substations and distribution systems, surveillance and control, communications, closed circuit television, traffic management systems and fire safety. This paper presents the development of an Artificial Neural Network (ANN) that predicts the cost of such installations on road tunnels. A data set is formed by collecting actual construction data from road tunnels of the 670 km Egnatia Motorway in Greece. The ANN has a feed forward architecture and is trained from the collected data using back propagation. Fundamental design parameters such as tunnel length, slope and selected lighting parameters are used as input parameters of the ANN. It is concluded that the ANN can serve as a very useful tool in the pre-estimation of construction costs of E&M installations on road tunnels.

Paper 5, Page: 41-48

Analysing Critical Factors of Infrastructure Funds: An Introduction

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Abstract: Public-Private-Partnerships have been used, globally, as an infrastructure delivery and

management system for both the developing and the developed countries. A growing demand for additional infrastructure has highlighted the use of infrastructure funds as an alternative to project financing. However, the current economic crisis and the inherent risks in infrastructure funding jeopardize this type of infrastructure development. This paper refers in brief to the fundamentals of infrastructure funding such as mode of application, infrastructure assets, and stakeholders. The most important contribution of the paper is the identification of certain critical factors that should be primarily considered by decision-makers involved in infrastructure investment appraisals. These factors are related to: a) the drivers for investing, b) the actual demand for infrastructure, c) the structure of the funds, d) the competition in the market, and e) the regulatory framework of operation. Along with the identification of the critical factors an analysis framework is presented that indicates the proper addressing of these factors in an infrastructure investment appraisal. The results from the validation of the critical factors and the analysis framework are expected to provide the decision makers with a secure base for evaluating the viability and profitability of infrastructure investment alternatives.

Paper 6, Page: 49-58

An Overview of the Implementation of Private Finance Initiative (PFI) in Malaysian Construction Industry

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Abstract: During the launch of Ninth Malaysian Plan (9MP), Malaysia is entering into the next phase of its privatization process through the introduction of Private Finance Initiative (PFI) to further streamline the implementation of privatized projects. Government has embarked on using PFI/PPP as one of the methods to procure building and infrastructure development projects. Malaysia appears to have taken a positive view on the potential benefit of a PFI/PPP model for its infrastructure need. These projects include the construction of schools, government quarters and economic zones (Imtiaz *et al.*, 2007). This study describes the key issues and challenges in implementing PFI in the Malaysian construction industry under the Ninth Malaysia Plan.

Based on the interviews conducted with government agencies, a Main Board listed construction companies, and consultancy firms, the results revealed that Malaysia is coming up with its own version of the PFI such that its financing arrangement is different from UK's PFI. In the Malaysia context, the government provides financing support indirectly through Employees Provident Fund (EPF) that provides Ringgit Malaysia (RM) 20 billion for PFIs. It will be the public sector that takes the financing risks rather than the private sector.

Paper 7, Page: 59-66

Construction-Friendly Bank: A Pre-Feasibility Study

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Abstract: Interviews with construction stakeholders re-confirmed the assertion that commercial banks have failed to understand construction. In contrast, banks respond otherwise. Construction personnel empathise with the concept of a 'construction-friendly' bank (CFB) but not banks! This impasse needs further study. Investigations reveal that a CFB could offer services hitherto not offered by commercial banks and currently available services could be packaged differently adding value to construction. Countries that have developed such responses include Mexico, South Korea and Sri Lanka and to a little extent New Zealand.

If banks were to respond to the needs of construction, they need to understand the nature of payment profiles, cost structures and supply chains, cash flow characteristics, contractual provisions, project performance characteristics in a local context whilst noting that construction is a heterogeneous industry in relation to financing needs. To what extent banks understand these is unknown.

A CFB could be set up as a unit within an existing bank or as a separate entity (with or without retention moneys), or as a public-private venture. A construction-friendly mix of strategic and operational decisions need to be made through a good understanding of the construction industry.

Paper 8, Page: 67-74

Building Theory on Monetary Retention Regimes

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Abstract: The aim of this paper is to explore and recommend a rational basis for setting up a retention regime for a given project. Despite a century of practice, there is no theory to provide guidance yet. Using insights gained from the recently developed theories on monetary retentions, this study argues that retention regimes should be designed to cater for the needs of those who have the power to control. Citing this as an important discovery, the study focuses on public clients and proposes three main objectives to be achieved and a tentative methodology for doing so in the pursuit of knowledge on how to set up a retention regime to cater for a wide variety of needs.

Paper 9, Page: 75-82

Sustainable Construction: Private Finance Initiative (PFI) Road Cases in the UK – The Theory

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Abstract: The construction industry is concerned primarily with the planning, design, production, alteration, maintenance and demolition of the built and human environment. The construction, maintenance and use of buildings and infrastructures impacts substantially on our environment and is currently contributing significantly to irreversible changes in the world's climate, atmosphere and ecosystem. The construction industry is facing ever-increasing demands to improve its sustainability performance. Public sector clients are increasingly asking for a sustainable approach in their specification and procurement decisions. It is hard to define sustainability exactly, but arguing over definitions does not advance the debate. Concern over the sustainability of the world we pass on to

future generations will continue to grow. A more sustainable future will mean a cleaner environment, a safer, and more cohesive and inclusive society and will be economically more successful and resourceful. These key concerns represent the three legs of the sustainability 'stool' – environmental, social and economic (BRE, 2001). Sustainability is still seen as a novel concept within the construction industry in many parts of the world with no settled definition. The industry has to understand what sustainability really is in its context and focus on creation, sustaining and dissemination of knowledge for sustainable construction across the many and diversified stake-holders in the construction projects.

This paper, based on case study research, will explain the sustainability implementation in a PFI road project in the UK.

Paper 10, Page 83-91

Sustainable Construction: Private Finance Initiative (PFI) Road Projects in the UK – The Reality

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Abstract: The construction, maintenance and use of buildings and infrastructures impacts substantially on our environment and is currently contributing significantly to irreversible changes in the world's climate, atmosphere and ecosystem. The construction industry is facing ever-increasing demands to improve its sustainability performance. Public sector clients are increasingly asking for a sustainable approach in their specification and procurement decisions. Sustainability is still seen as a novel concept within the construction industry in many parts of the world with no settled definition.

This paper, based on case study research, will describe the sustainability implementation in a series of PFI road projects in the UK. It is a follow up to the theory paper entitled "Sustainable Construction: Private Finance Initiative (PFI) Road Projects in the UK – The Theory", also presented at this conference.

Paper 11, Page 92-98

Factors Affecting Project Cost and Time in Construction

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Abstract: Cost and time overruns are usual practices in most of construction projects. These problems should be removed via suitable methods. To find out a successful solution, factors affecting cost and time overruns should be first determined and their impacts on these overruns should then be analyzed. In this study, the factors that cause delays and cost extensions were considered. In order to pinpoint their negative effects on cost and time schedule, a questionnaires survey was applied to project managers of 45 construction firms in Antalya, Turkey. As a result, how frequent these factors are encountered in practice was presented by means of the relative importance index method

Paper 12, Page 99-106

Estimation of Building Costs Using Geographic Information Systems

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Abstract: In traditional construction cost estimation, quantity take-off is usually performed manually using the design drawings. The traditional method, in general requires a lot of time and effort as several similar calculations are repeated for each item included in the project. In this study an alternative method for construction cost estimation is presented. In the proposed method, geographical information systems (GIS) and computer aided design (CAD) drawings are used to perform quantity take-off. The method is applied to a building project for quantity take-off of concrete, formwork and reinforcement bars. The quantities were calculated by integrating the CAD drawings of the project into the ArcGIS software. The main advantage of the proposed cost estimation system is that it does not require additional data other than CAD drawings, and method can be implemented using existing CAD drawings of the contractor. The method provides an efficient tool for quantity take off and cost estimation of construction projects without requiring

additional drawings and cost. ArcGIS also enables 3D visualization of the project rendered from 2D CAD drawing as a result benefits of 3D representation is obtained as by-product at the end of cost estimation. Benefits of the proposed method are discussed along with limitations and future enhancements.

Paper 13, Page 107-114

Cost Estimation of Trackworks of Lightrail and Metro Projects

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Abstract: The main objective of this work is to develop models using multivariable regression and artificial neural network approaches for cost estimation of the construction costs of trackworks of light rail transit and metro projects at the early stages of the construction process in Turkey. These two approaches were applied to a data set of 16 projects by using seventeen parameters available at the early design phase. According to the results of each method, regression analysis estimated the cost of testing samples with an error of 2.32%. On the other hand, artificial neural network estimated the cost with 5.76% error, which is slightly higher than the regression error. As a result, two successful cost estimation models have been developed within the scope of this study. These models can be beneficial while taking the decision in the tender phase of projects that includes trackworks.

Paper 14, Page 115-119

Structural Equation Model of Estimating Final Construction Cost of Road Tunnel

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Abstract: In the preliminary design phase of technical projects, the selection of the best

alternative solution requires reliable early estimates of construction cost. This is particularly true in the case of tunnels, where underground risks are involved and cost overruns are frequent. To estimate final construction cost of road tunnels in a more realistic and systematic manner a structural equation model (SEM) was developed. SEM is a systematic combination of confirmatory factor analysis, multiple regression analysis and path analysis. More importantly, SEM has an error variable that capitalizes on both measurement errors and structural errors by accurately reflecting the actual phenomena. SEM allows the user to visually depict the paths of how several variables affect the final construction cost of an underground project. A set of geotechnical parameters influencing the final construction cost was selected, based upon an extensive literature review and consultations with a number of experts. Detailed information regarding 49 km of constructed tunnels was gathered in an extensive database and exploited by SEM. "Goodness of Fit" of the model was tested for accuracy and robustness.

Paper 15, Page 120-126

Implementing the Balanced Scorecard in the Greek Construction Companies Projects

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Abstract: In the last few years, Greek construction companies have been characterized by strong growth of productivity and remarkable progress. This was driven by the Third Community Support Framework, falling interest rates, and merely by the extensive construction works for the 2004 Olympic Games. Recently, a recession was noticed after the Olympic Games, projects' completion. In order to study the status and potential of the construction companies in this paper we develop a tool based on balanced scorecard (BSC) and sustainability principles to effectively monitor and control project activities for the purpose of improving project results. We propose using sustainability balanced scorecard (SBSC) as an extension of traditional BSC as such a tool by adding a sustainability perspective. The implementation of this tool through monitoring

metrics can control the strategy implementation process, not just to realise short-term financial outcomes but also to develop sustainability issues.

Paper 16, Page 127-134

A Criteria Model for Budgeting and Assessing Industrial Sites Location in Developing Economy

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Abstract: Industrial sites are selected in many of the developing countries without taking into consideration some pertinent criteria that are directly affecting the sustainability of such industries in the locations after commissioning. Industries are located in some areas based on political influence rather than facility availability that support industry's productivity. In this study a criteria model was developed for assessing the present industrial site locations based on predetermined influencing factors called criteria. In the model provision was made for the sorting out of deficient influencing factors for the purpose of upgrading to acceptable level called benchmark through periodical allocation of appropriate funds. In validating the model, identified industrial sites located in selected States of Nigeria were surveyed. Data were collected on factors such as power supply, marketability and raw material availability which were considered influential to the sustainability of industry's site in the respective areas. Data were analysed for the criteria identified along the line of industrial categories which included large-, medium-, and small -scales. Benchmarks, as well as levels of criteria in the respective region were determined using statistical weighted averages and the results were used as input to the model. The output results of the model showed that none of the industrial sites located in the selected six States of the South-Western Nigeria were productivity supportive. However, a good performance was achieved in a site with a budget of \$13 million (US Dollars) for the upgrading of the deficient facilities in the next three years.

Paper 17, Page 135-142

A Dynamic Model for Sequential Expansion in Building, Machinery and Manpower Based on Gradual Funding

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Abstract: Adequate resources such as land, manpower, and material that are supportive to industry construction and development are available in many developing countries such as Nigeria. Development of these resources to the industrial level is, in most cases, being hindered by inadequate funding which is critical in the effective transformation of the industry to the set target. The funding, no matter how meagre it is can still be used effectively if a framework that allows sequential disbursement of it is in place. This study provides a dynamic model that is capable of sequentially expanding the industry building, outputs, machinery and manpower based on the level of funding, while the targeted capacity are not violated. In the model the quantity produced (output) is controlled by the size of machinery and manpower which in turn determines the size of the building. The three parameters of control; namely industry's output, machinery and manpower are modeled using multiple regression method. Funding serves as prime mover on the road of meeting the expected target. The system also allows the prediction of expected capacity so that arrangement is made for meeting the future industry's building size requirements. The implementation of the model in a wire and cable industry in Nigeria shows that the expansion of the industry's building varies with types of products, size of output, machinery and manpower, the available fund can cope with. This makes the model to have potential in solving the problem posed by funding on the development of industry in developing economy.

Paper 18, Page 143-149

Investment Appraisal of a Small Hydro Power Plant: A Case Study for a Small Hydro Power Plant in Bosnia and Herzegovina

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Abstract: Many developing countries today are facing a growing demand for energy to support the development taking place. With the prices of crude oil reaching record levels and with the introduction of stricter environment protection laws; many of the countries are looking towards alternative supplies of energy which are cheaper, renewable and eco-friendly to meet the growing demand. As a result there has been an increasing trend in exploitation of hydro-power resources in countries where it is possible to utilize the water resources in order to produce energy.

This study will analyze a proposed small hydro-power plant project in Bosnia and Herzegovina for which a detailed financial analysis was performed. Based on the Net Present Value (NPV) and Internal Rate of Return (IRR) obtained from the financial analysis a decision can be brought whether this project will be feasible or not. Factors which may affect the outcome of the project such as an increase inflation, increase in the real wage, movement in the price tariff of electricity, investment cost over-runs and others will be determined by carrying out a sensitivity analysis for the project. The financial analysis will also show how the financing of the project may be affected by an increase in inflation by looking at the Debt Service Capacity Ratio (DSCR) and the Annual Debt Service Coverage Ratio.

Paper 19, Page 150-157

Exploring Estimator Behaviour in Pricing Road Projects

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Abstract: Cost estimates form a key element in the planning and management of projects. It is therefore common to find that project staff devotes considerable effort to attaining accurate estimates. The ability to produce cost estimate to a reasonable level of accuracy and in a timely fashion to support the efficient planning of a project is influenced by a number of factors. These include the skill levels and numbers of estimators, national, industry and project related factors, as well as the decision orientations of cost estimators. The current notions support the argument that the amount of information available to estimators at the point of their decision influences the accuracy. While this is true in very many cases, it does not explain fully the contribution to estimating accuracy. Estimator behaviour has a significant contribution to achieving a high level of accuracy. In this paper, the authors focus on the subject of estimator behaviour in project cost decision making, and how the effects of the behaviours influence the accuracy of project cost estimates. The paper explores the personal and situational factors that are associated with the accuracy of estimates and proposes how these factors could be addressed for improved accuracy in cost estimating within the construction industry.

Paper 20, Page 158-165

Investigating the Range of Estimating Accuracy in Road Projects

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Abstract: Cost estimates forms a key element in the planning and management of project and project staff expend considerable effort preparing them. The ability to produce cost estimates to a reasonable level of accuracy and in a timely fashion to support the efficient planning of a project is influenced by a number of factors. These include the skill levels and numbers of estimators as well as national, industry and project related factors.

For any national construction sector, these factors combine to provide an indication of the capacity to, and constraints in the preparation of accurate estimates. In Ghana, the Ministry of Transportation is responsible for managing the road sector. Three of the Agencies under the Ministry namely, Ghana Highway Authority (GHA), Department of Urban Roads (DUR), and Department of Feeder Roads (DFR) are responsible for developing and maintaining all the road networks of different classes throughout the country. While it is the responsibility of road sector contractors to produce the estimates that they submit for their tenders to undertake any proposed road projects, the roads development process requires a substantial estimating effort on the part of the Agencies to form the basis of a business case that justifies a decision to go ahead with any proposed scheme. The output from the estimates provide relevant data for establishing the national roads budget as well as information to support any application for donor funding or internationally sourced loans to undertake the projects.

The paper presents the results for an analysis of the national estimating capacity for the three Roads sub-sector Agencies as part of a wider research project to improve the estimating accuracy in Ghana. It examines the estimating procedures that exist within

the three Agencies as well as establishing estimating load to staff ratio to identify current weaknesses and constraints in estimating accurate road project cost. The paper proposed estimating boundaries as guide for estimators in the Road sector in Ghana.

Paper 21, Page 166-177

Detailed Estimating Practices of Construction Firms in Pakistan

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Abstract: The cost estimate is considered one of the most important and critical phases of a construction project. Preparing reliable and accurate estimates to help decision makers is the most challenging assignment that cost engineers and estimators face. Pakistan, a developing country supplemented by fast growing population, needs adequate and careful allocation of funding for projects of basic amenities and infrastructure. Cost estimating practices play a vital role in procuring the necessary funding for these projects as well to undertake these endeavors successfully. This research presents the results of a questionnaire survey, based on the responses of 46 local construction contracting firms in Pakistan, to assess the current cost estimating practices followed by the contracting firms in Pakistan, along with identifying their cost estimating needs, requirements, considerations, procedures, information items needed for estimating, problems hindering the abilities of estimators, and use of information technology to produce accurate cost estimates. The paper identifies the need for a professional construction management information

system to provide timely, accurate and consistent project costing, the need for good communication with subcontractors and material suppliers to keep pace with market trends, and a need to replace the current low bid project procurement environment by a performance based award system for the local construction industry.

1.2 Decision Making and Risk Analysis

Paper 22, Page 178-185

Vulnerability Assessment of waterfront Residential Properties to Climate Change

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Abstract: This paper is part of an ongoing research project designed to develop a dynamic model for assessing current and future vulnerability of waterfront residential properties to sea-level rise (SLR).

SLR is one of the best recognized effects of projected climate change in recent literature. Increased storm surge height due to SLR can cause significant problems for low-lying coastal areas. Millions of people who live near the sea may be forced to displace due to coastal flooding. As sea level continues to increase due to global warming, decision makers will need to have better tools to understand the extent and timing of coastal hazards.

Considering the complexity and dynamic nature of coastal systems with many feedbacks and dependencies changing over time, the research will focus on modelling temporal and spatial variations of coastal flooding in assessing vulnerability of the systems to SLR and storm surges

Paper 23, Page 186-193

Investment into New Technology under Uncertainty Conditions

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Abstract: The Republic of Croatia is undergoing a massive reconstruction of large infrastructure systems, specifically design and highway

construction with accompanying service buildings. Hence the need for the foundation work for bridges, viaducts, overpasses, office and public service buildings on the soil of low stiffness, e.g. of inadequate bearing capacity. Various soil improvement technologies might enhance its bearing capacity, e.g. keep under control or reduce total and differential settlements. The paper presents methodology of the decision making on a probable purchase investment into a potential soil improvement technology on the example of a typical highway structure. Firstly, criteria are set on the basis of defined designers', investors' and wider community's interests according to which the rank list of foundation technologies would be made up using multi-criteria analysis of AHP method. Then, using the tree method decision and applying expected values criteria the decision on investment into soil improvement technology purchase will be reached. Providing that the decision on investment has been reached, the decision on the selection of a proposed technology by means of a decision tree will be made.

Paper 24, Page 194-201

A Fuzzy Logic Approach for Contractor Selection

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Abstract: Contractor selection is the process of selecting the most appropriate contractor to deliver the project with specified quality, time, and cost. Construction clients had realized through the last decades that the lowest price bid is not always the best. Evaluation of contractors based on multi-criteria basis is, therefore, becoming more important to the construction industry. In most countries, contractor selection is done upon regulating laws that take into consideration different circumstances involved in the industry. In Egypt, for example, tender law is evaluating contractors according to

both technical and financial basis, but no specific technical criteria were determined in each type of construction industry. This paper presents a fuzzy logic framework to help decision-makers to evaluate the capability of the contractors in residential building projects. An in-depth literature review of the criteria that may affect prequalifying and selecting the appropriate contractor in different countries are presented. Semi-structured interviews were conducted with construction experts to select the appropriate criteria that suit Egyptian industry. An illustrative example is then presented to demonstrate the data requirements and the application of the method in selecting the most appropriate contractor for residential building projects.

Paper 25, Page 202-209

A Spatial Decision Support System for Highway Infrastructure

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Abstract: Modern highways consist one of the main infrastructure of a country and their maintenance in order to achieve the best condition of operation should be a major concern. Extended damage of highway components, i.e. a bridges or tunnels or great slope failure caused by landslides, earthquakes, floods or other causes can produce a disaster that could affect scores of people.

In this paper, a Spatial Decision Support System (SDSS) for deformation monitoring of highway technical works is described. The system uses GIS technology as a base and consists of the following modules:

1. An extended deformation monitoring system based on geodetic and geotechnical instrumentation.
2. Environmental conditions monitoring.
3. Monitoring of construction health (optical and instrumented inspection).

4. A knowledge-based system that analyses all data and makes a rough risk assessment, triggering the alarm for possible immediate failures.
5. An alarm system to ensure the instant/direct authority action.
6. The overall assessment of the results and the final decision level due to geo-informatics solutions.

Paper 26, Page 210-217

Equipment Supplier Selection under Multiple Criteria

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Abstract: During the design and construction phase one significant factor for the project's successful outcome, is the selection of the appropriate construction equipment supplier. It is important to choose the best supplier wisely, as his performance could potentially affect the project schedule and final cost. This paper, aims at providing a standardized approach in selecting the best supplier, through the use of an appropriate mathematical function. The synthesis of the specific function is based on research conducted through a prototype questionnaire survey. The survey aimed at defining weights for a predefined set of criteria, concerning the selection of equipment suppliers. After the completion of the survey, the data was statistically analyzed. The application employed was the SPSS. The various statistical results were compared and the criteria weights were estimated. The research findings led to the construction of a final function which attributes scores to each of the construction equipment suppliers and indicates the best choice for the project under consideration.

Paper 27, Page 218-227

Management of Reservoir Operation by Fuzzy Logic Decision Making

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Abstract: One of the basic issues in the construction management is decision making. When variables face uncertainty, for an instance in reservoir operation, fuzzy method is applicable for elite modeling. In this example it is possible to predict reservoir released water by fuzzy logic to achieve the optimal policy for long term use, based on net discharge, downstream demand and initial reservoir storage. As a case study, Dez dam reservoir in Iran is studied in this research. Results show desirable prediction by proper recognition of the problem and adequate elite modeling.

Paper 28, Page 228-237

Evaluation Support in Strategic Decision Making Processes Comparing Tools and Methodologies

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Abstract: The reasoning we will be proposing underlines a twofold meaning of the term evaluation: to evaluate "in order to program complex and integrated projects"; and to evaluate "in order to structure the analysis of complex

transformation plans". Implicitly we assume the distinction between a strategic and a tactical-operational level: the first of these follows a negotiating procedure, while the second resumes classic methodologies concerning the analysis of investments: those are theoretical and empiricist references, which need to be analyzed in relation to the specific circumstances of the real estate context and the complex urban transformation plans in economic systems.

First of all, it is necessary to clarify the framework of steps and instruments involved in the entire real estate development process, according to both private and public profiles, regarding the most recent complex planning procedures in Italy. The first part of the paper therefore focuses upon the role of assessments in the preliminary phase in supporting the decision making process and the delicate moment of briefing, which is absolutely necessary to shape and define strategic choices (policies, guidelines, programs) and also tactical operating choices (precise plans that put strategic choices into effect and make them operational).

The second part of the paper underlines the importance of specific evaluation tools required to articulate complex analysis of transformations, to shape problems and to resolve them. Finally, we propose to examine the Strategic Choice Approach, a methodology aimed at managing uncertainties and developmental decision making processes, especially for public projects, which are applied with other analytical procedures.

Paper 29, Page 238-244

Tower Crane Placement Analysis

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Abstract: Any construction project requires a plan for construction material on site transport from the storage area or transport means to the place of its use. Tower cranes are commonly used for site transport. The article analyses the options for tower cranes positioning on site, identifies option based risks and recommends situation dependent tower crane solutions.

Paper 30, Page 245-252

Strategic Group Analysis by Using Fuzzy Clustering

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Abstract: Strategic group is a group of firms in an industry following the same or similar strategy along a set of strategic dimensions. The aim of strategic group analysis is to find out if clusters of firms that have a similar strategic position exist within an industry or not, therefore it can be used as one of the methods for revealing the competitive structure. Using a theoretical conceptual framework applicable for the construction industry and fuzzy clustering, the objective of this research is to identify possible strategic groups within the Turkish construction industry. In this research, by considering the cluster validation techniques developed for fuzzy clustering, the number of the strategic groups is determined as three. The membership degrees of the companies to all clusters are obtained at the end of the analysis. It is concluded that the companies in the same strategic group do not necessarily implement the strategic recipe of the group at the same degree. Therefore, the traditional strategic group concept in which the clusters are wholly separated does not reflect the real strategic group structure of the Turkish construction industry and heterogeneity of strategies implemented in each group. Findings of this study can be used by professionals to understand their current strategic positions within the competitive environment and even in their strategic groups.

Paper 31, Page 253-260

Solution of Unbalanced Transportation Problems Using Simplified Generalized Network Algorithm (SGNA)

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Abstract: This paper deals with an application of Generalized Networks on unbalanced transportation problems in construction site management. Sample problem is about minimal cost-maximal flows of concrete materials required from construction site. Two factories can supply any of three construction

site with a particular product (concrete materials). The demand for this product from each of the site has different capacities. This problem can be called unbalanced transportation problem. Because, demand amount and supply amount are not equal to each other. In this problem, supply center (concrete plants) can not supply the demand. The capacities of supply center are less than demand center (construction sites). Maximum production at concrete plants, the variable production cost per m³, and the transportation cost per m³ from each factory to each site are different.

In this paper, a new algorithm called Simplified Generalized Network Algorithm (SGNA) based on networks has been derived from Generalized Networks (GN) for solving sample problem. The classical solutions of the sample unbalanced transportation and SGNA solutions of same unbalanced transportation problem have obtained using analytical solution techniques. These solutions have been classified and compared with each other. The suggested new algorithm SGNA give us same solutions of other solution algorithms. This shows that SGNA is capable and useable for solving of unbalanced transportation problems mentioned construction site management.

Paper 32, Page 261-266

A Proposal for Architects' Design Performance Assessment Using Objectives Matrix

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Abstract: The overall intent of this research is to provide clients and architects with basic evaluation system that can be used to understand and improve task performance of architects so as to optimally satisfy the client's requirements and achieve high quality overall project performance. By means of 5 typical design goals, i.e. Aesthetics, Functionality, Buildability, Economics, and Environmental Sustainability a basic 'objectives matrix' is formulated to exemplify the assessment of architects' design performance. As an outcome of the study, a basic model for evaluating architects' design performance is pointed out with the potentials in the industry. It is concluded that a generally accepted evaluation system for architects will be beneficial to quantify project performance within the construction industry.

Paper 33, Page 267-274

A Conceptual Framework to Assess Architectural Design Quality by Analytic Hierarchy Process (AHP) and Its Integration to Building Contracts

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Abstract: During the last century theorists have discussed and tried to reveal characteristics of architectural design processes. Since each building design project is unique and has its own context, classification and topics of interests are about the structure of the decision making process, parallels among architectural designing, creative behaviour and problem solving. Recently there are various methodologies developed in order to support multi criteria decision making processes. Frequently refereed ones are Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP). AHP is a powerful and understandable methodology that allows groups or individuals to combine qualitative and quantitative factors in decision making process. ANP methodology allows groups or individuals to deal with the interconnections (dependence and feedback) between factors of complex structure in decision making process. AHP structures a decision problem into levels forming a hierarchy, while the ANP is using a network approach (Van Bakel, 2005; Topçu, 2009).

This paper tries to put out a conceptual framework of a PhD study previously started to assess architectural design quality from the perspectives of design team, client, users, society and contractors by using AHP and its integration to building contracts. The outcomes of the paper will be used in order to develop a handy tool while deciding on appropriate building contract which architectural design quality plays an essential role.

Paper 34, Page 275-283

Home-Buyers' Product Selecting Criteria vs. Satisfaction Rate in Northern Cyprus Construction Market

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Abstract: Home-building is a major segment of construction, which plays an important role in the overall economy of Northern Cyprus. Since satisfied customers are the backbone of the home building industry, providing superior quality to keep customers satisfied deserves attention. Most of the home-buyers in the specified sector sign their contracts with the home-builder contractor firms while the product (house) is still in the design stage, before the construction stage even started. Therefore, the correct criteria which the clients should consider while selecting the product to buy become even more complex. In an effort to determine the correct criteria that should be considered by the home-buyers in selecting the highest satisfaction producing products, this study examines the criteria currently used in the sector by presenting survey findings of 80 home-buyer clients in the specified market. The results revealed that there is a significant difference in the criteria that should be considered to reach higher satisfaction for different types of client groups. Furthermore, it was found that although 'product related criteria' are assigned high importance levels in the market, 'contractor related criteria' definitely need to be assigned more importance in the product selection stage to increase the satisfaction levels of the clients. Additionally, it was found that dissatisfaction due to 'service' provided by the contractors was more than that produced by 'product' related factors. The framework presented in this study will serve as a basis for a model, which will guide the home-buyer clients in selecting the correct product that will produce highest satisfaction for them at the end.

Paper 35, Page 284-291

Regeneration Decision-Making: Some Early 'Opportunities' and Decisions for SURegen

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Abstract: The multi-disciplinary EPSRC funded SURegen project is developing a digital decision support aid that will capture good practice in sustainable urban regeneration for use by practitioners for real time decision-making, training and education purposes. It will achieve this by identifying the key decision points in the early stages of the regeneration process, such as diagnosis and visioning, and simulating a variety of decision impacts or outcomes. This paper will provide detail about the development of the project's general approach and technical methodology, its data collection techniques and the important role that the project's industrial partners are playing in ensuring that the project delivers a tool that is both contextually specific to the Manchester case studies whilst providing good practice examples of interest to regeneration throughout the UK and beyond. It provides details of the outcomes of a recent workshop exploring the project partners' aspirations and priorities for the SURegen decision-support tool.

Paper 36, Page 292-299

Risk Management: A New Project Management Perspective

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Abstract: Risk management in Botswana has been very ineffective in assisting projects to finish on time, on budget, and to meet client's/buyer's expectations. Traditional risk management attempts to use preplanning to identify risks and implement risk management/monitoring to minimize the risks. However, it seems risk management in Botswana has not been implemented properly or not successful. The project performance in Botswana has a poor record. The researchers are attempting to identify if the traditional project manager's risk management model is too difficult to implement. In analyzing the problem in Botswana, the researchers have discovered a new project management risk model, with an entirely different approach to risk. The new model is an outgrowth of the highly

successful Performance Information Procurement System (PIPS) and the Information Measurement Theory (IMT)/Kashiwagi Solution Model (KSM) concepts. The authors propose that the new model is easier to understand and implement. The approach has been presented to the Botswana industry and has received preliminary approval. The model will be tested and the results will be discussed in a follow-up paper.

Paper 37, Page 300-307

Risk Analysis in Transport Infrastructure Concession Project Funding: The Case of Thessaloniki Submerged Highway Project

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Abstract: PPP's are increasingly used for the delivery of new assets and/or services that traditionally were the responsibility of the Public Sector. In the case of transport projects the most popular PPP structures are the DBFO concessions. Concessionaires in these cases collect revenues through actual or shadow tolling or both, to pay off the capital and their loans as well as the operation and maintenance costs. The success of PPP's is based on the allocation of risks among the public and private sector partners and the attainment of value for money as compared to conventional structures. Risks must be undertaken by those who can best deal with them. Weakness in achieving optimal risk allocation will create undesirable effects to both parties of the partnership and will bear financial and socioeconomic losses. This is shown by the Thessaloniki Submerged Highway case where unforeseen factors forcing reallocation of risks in a non-optimal way, created a sequence of events, influencing the whole project. Shifting some risks from one party to the other, affected all project stages from design to construction and to operation. As a result all financial and operational performance indicators are expected to deteriorate. The risks at stake are related to legal, archaeological and environmental aspects. It turns out that in all cases construction and operation costs will increase while demand and revenues will decrease. At the same

time socio-economic benefits will be reduced and finally public acceptance for the project may be lost. The conclusion in this case is that avoiding dealing with a risk of low cost for one party in a PPP, bears a disproportional cost not only to the other party, but to both the public and private sector, as well as to the facility users and the public.

Paper 38, Page 308-315

Evaluation of Risk Perceptions in Construction

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Abstract: Client are advised by many different professionals about the level of risk inherent in construction projects, and so there is the possibility of inconsistency in the assessment of similar risks by different professionals if they exhibit different risk perception characteristics. Thus, the main objectives of the study were to evaluate risk perception and explore factors affecting the perception of risk drawn from psychological and strategic management disciplines. This study thus contributes to a finer-grained understanding of what factors affect risk perceptions and how professionals exhibit different perception of risk. It is found that theories from psychology and strategic management are useful in explaining why people have different perceptions of risk. The study indicates that risk perceptions were affected by heuristics and biases, problem framing and risk propensity. The main implication from this study is that combining the risk ratings of different professionals to indicate the significance of particular risk is inadequate and misleading and risk requires further investigation in this direction.

Paper 39, Page 316-323

Case Studies of the Applicability of Risk Management Practice in Klang Valley, Malaysia

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Abstract: This research is focuses on the practice of risk management (RM) in Client's organization and aims to identify the level of awareness among construction professionals towards risk management and to examine the policy undertaken when dealing with risks in a construction project. Apart from that, it also aims to identify the problems and challenges for the implementation of risk management in Malaysian construction industry.

A series of interviews were carried out in order to obtain a better view on the implementation of risk management in the Malaysian construction industry. It was found that Malaysian clients are slowly accepting risk management tool that will help in managing a construction project effectively and successfully.

Based on the findings from the interviews there are a number of clients who know about risk management and who have attended training and some of them have even practice risk management in their organizations. At least, it's been proven that there are organizations that have implemented risk management in their operations although this is only on a small scale. It can be concluded that risk management still has a long way to go in order to be accepted and recognized in the Malaysian construction industry.

Paper 40, Page 324-331

Risk Management of Public-Private Partnership (PPP) Infrastructure Policy and Implementation: A Philippine Contractors Point of View

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Abstract: Risk is a fundamental feature of any Public-Private Partnership (PPP) and it substantially influences the overall project cost. A detailed analysis is conducted by the project actors prior to deciding whether to embark on the project, and what type of PPP would be the most adequate vehicle for the project. The veracity and initiative of the consortium on determining the risks will either make or break the financial standing of the company.

This study focus on the determination of consolidating all the risks attributable to Philippine's

Build Operate Transfer (BOT) through cursory review of implemented projects, structured interviews and distribution of questionnaires to various PPP players in the industry. The political risks with their corruption sub-risks rank as the most critical risk in Philippine BOT system as categorized by the country's key players. The inadequacies of the contractual provisions, the lack of transparency in procurement as well as the prevailing political instability attributed to delays in the project implementation are the major findings of this paper.

Paper 41, Page 332-339

Managing the Risk of Contractor Failure

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Abstract: The topic of contractor failure has become a major research domain since the beginning of the 1980s. Construction is a risky business with many features like long period of time, complicated process, financial intensity, environment and dynamic organizational structure. The aim of this paper is to find out the factors effecting contractor failure.

In the first phase contractor failure ratio for public procurement is found by investigating the data of the Turkish Ministry of Public Works and Settlement between the years 1999 and 2006. It is found that 10.5% of the public projects end in construction default. The second phase of the study involves a questionnaire survey to find out why construction companies fail in Turkey. The first part of the questionnaire includes the determinants used by Dun and Bradstreet as the causes of failure classified as organizational, environmental, and performance factors. The second part of the questionnaire includes questions about the organizational structure of the company.

It is found that the most effective causes of contractor failure are receivable difficulties, insufficient capital, lack of managerial experience, lack of business knowledge, and family problems. It

is observed that ego problems, removing performance barriers, monitoring of performance, adaptation to modern work models, and clarified directions are found as major problem areas for the organizational structure of the company.

Paper 42, Page 340-347

Cost and Time Focused Risk Analysis in the Turkish Construction Industry

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Abstract: This study reveals that the present position of Turkish contractors in terms of the risk management of cost and time overruns in construction projects. To this aim, 68 companies participated in a detailed questionnaire of which data was evaluated by means of the frequency analysis and the relative importance index method. According to the findings of this research, it was found out that Turkish firms have cost-based management understanding and perceive financial/economic risks as the most important risk group. Although the contracting firms indirectly consider possible effects of project risks, they do not apply any risk management approach. However, clients withstand project risks via transferring most of them to contractors.

Paper 43, Page 348-357

Risk Management Maturity Models: A Review and Future Directions for Improvement

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Abstract: Risk management is now an accepted discipline with its own language, philosophy, techniques, procedures and tools. With the increased awareness on the benefits of having a formal structure to manage risk, many organizations are seeking to introduce risk management into their

organizational and project processes or to enhance their existing practices. As Project Management Institute (PMI) claims, although the core elements of project risk management are known and used by many organizations, there are a number of areas that risk management needs to be developed in order to build on the foundation that currently exists; and the ability to measure the effectiveness in managing risk is one of the most important of these areas. A risk management maturity model is an assessment tool designed to measure risk management capability of projects or organizations and provide objectives for improvement. In this study, after a literature survey on the existing risk management maturity models, six of them have been identified as outstanding and reviewed. After describing each model in detail, the models are evaluated in terms of their effectiveness and usability. Built on the evaluations, future directions for the development of an improved risk management maturity model applicable for the construction industry are proposed.

Paper 44, Page 358-363

Role of Insurance in Mitigating Natural Catastrophic Risks

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Abstract: Scientific evidence indicates that a warming world will be accompanied by more changes in the intensity, duration, and frequency of climate and geological extremes. In recent decades, there has been a significant increase in natural hazards that have negatively affected the U.S. economy. Based on the response to recent hurricanes, the U.S. is not well enough prepared to deal with the financial management of large natural disasters. The main goal of this paper is to address the theory and practice for utilizing insurance as a supportive tool for mitigation of the negative financial effects associated with extreme natural events. Under this paper, the author reviews concepts pertaining to climate change and insurance for natural catastrophes. It is shown that a set of risk analysis and quantification problems make it difficult to design and implement realistic preparedness and response policies for catastrophes risk management at the regional, national, and international levels. Moreover, it is evident that the insurance industry fails to mitigate natural hazards because of the mismatch between the size of annual premiums and the size of maximum annual losses.

Consequently, the author outlines the theoretical foundations for development of public policies that integrate both the financial and socioeconomic dimensions to effectively manage natural catastrophes. It is perceived that this approach provides ways for accurately deciding on who should be responsible for payment of insurance premiums and creating provisions of reinsurance for natural catastrophic risks. This should serve as a leading step towards integrated societal resilience in management and insurance for natural catastrophes.

2. Construction Project Management

2.1 Project Planning and Control

Paper 45, Page 364-371

Construction Sequence Planning – An Interaction Diagram to Determine the Output of Reinforced Concrete Works

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Abstract: To determine the duration of reinforced concrete works, the concrete quantities of the structure or building section are required as well as the output (e.g. cubic meters per day or shift). To date, these calculations have been carried out on the basis of specific project data, arriving at individual durations for each and every section.

The interaction diagram shown in this article provides an option to easily execute these calculations via nomogram, and to obtain graphical results. The diagram enables the calculation of the required output (e.g. for a predetermined completion date), the duration of the works, the total attributable working hours, the maximum (economically) permissible labor productivity expressed as working hours per m³, and the number of workers needed for the total reinforced concrete works.

The graphs interlink the results of a number of individual, standardized computations. For each of these computations, parameters are varied within reasonable, practically feasible ranges.

The resulting four diagrams are connected on an interaction diagram that is easy to use in day-to-day practice. Due to the fact that the diagram can be 'operated' from any of the four quadrants, it is especially user-friendly.

During the initial planning phase of a project, the presented diagram may become particularly useful for time scheduling and for the evaluation of construction alternatives.

During tendering and especially for job calculation (once the contract has been awarded), these graphs may become very helpful. It is believed that these diagrams might soon prove indispensable for actual construction scheduling and sensitivity analyses (e.g. when deciding on alternative construction methods).

Paper 46, Page 372-376

Application of Chronometric Measurement and Simulation Systems for Better Planning and More Productive Execution of Construction Projects in Croatia

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Abstract: This paper gives an overview of a simple method by which a small or medium sized company can standardize its operations on construction sites. The first section of the paper gives an overview of the current state of practice in the Croatian construction sector and motivates the practical need for creating simple normative databases within companies and projects. The second section briefly describes two simple methods for measuring productivity on construction sites and formally documenting the results into a database: chronometric measurement system and discrete-event simulation of construction operations which is also illustrated on a test case. The final part of the paper further elaborates motives and potential benefits of using these approaches in the context of sustaining growth of the national construction sector and enabling further innovation within it.

Paper 47, Page 377-383

Advanced Line of Balance Method (ALoB) in Partly-Repetitive Model-Based Scheduling

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Abstract: Model-based scheduling is defined as the semi-automated or iterative processing of project information that is retrieved from building information models, i.e., product models and resource and cost models. Model-based scheduling is becoming the new generation of scheduling. As a transition into the new mindset, it would be appropriate for model-based scheduling to evolve from basic scheduling methods such as activity-based (CPM – Critical Path Method) and location-based (LoB – Line of Balance Method) scheduling methods. The advantages of location-based scheduling methods over activity-based scheduling methods in repetitive construction projects have been thoroughly confirmed in the past by many researchers. Location-based scheduling methods such as Line of Balance (LoB) are particularly suited for use in building projects because of the repetitive nature of building construction. However, even though building projects are basically composed of repetitive serial activities, they also involve unique, complex, and non-repetitive activities; in many cases, locations differ (e.g., in size) and so do activity contents. A location-time diagram called Advanced Line of Balance (ALoB) was developed to extend the application area of this method into partly-repetitive projects and is presented in this paper. Hence the aim of this paper is to investigate the use of ALoB in partly-repetitive environments. The paper contains three parts: (1) the LoB literature is discussed, (2) the methodology of ALoB is discussed, and (3) the use of ALoB in model-based

scheduling in partly-repetitive environments is discussed.

Paper 48, Page 384-391

An Assessment of Nominal and Actual Productivity of the Construction Equipment based on Several Earth-fill Dam Projects in Iran

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Abstract: Optimum planning for heavy construction equipment is a vital task in succeeding the construction projects. In a construction plan one should significantly concentrate on the type, number and schedule of presence of the equipment at the project site. In this paper, we have studied the productivity of a model of dozer, a wheel-type loader, a crawler-type loader, a grader, a sheepsfoot roller and a smooth wheel roller, at the site of several earth-fill dams around Iran. Each model was individually considered and the site conditions were taken into account. The nominal hourly production of the equipment was derived according to the data obtained from Caterpillar, Komatsu, and Volvo manufacturers. The actual production was calculated according to the statistical data from various earth-fill dams in Iran. The derived results showed that the actual production of a sheepsfoot roller had the least difference with its nominal production; whilst the loader had the most difference in actual and nominal production (i.e. it had the lowest working efficiency).

Paper 49, Page 392-400

Historical Data-Based and Simulation-Aided Probabilistic Approach for Cost-Time Control

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Abstract: Cost and time control has long been an essential part of construction management, which is considered a series of decision-making processes based on uncertain site conditions as well as periodic feedback with contractual requirements. Traditionally, a number of researchers have sought a way to provide feasible methods for such types of decision-making, which is largely attributed to deterministic approaches that lack the delivery of project uncertainties. The current probabilistic method, however, still leads to a shortage of practical applications because, more often than not, the probability patterns are less connected with real performances and, further, the actual properties of a given activity are not adequately addressed. In addition, such methods are frequently under attack due to the absence of methods for assessing alternative scenarios to improve as-is performance from the project manager's perspective. This study attempts to help narrow the gap in the current probabilistic approaches for cost-time analysis and scenario simulation. The reality of a probabilistic approach based on historical data accrued from each activity's performance is proposed. Then, the framework for extracting alternatives to enhance current performance is also presented through discrete event simulation as well as the project manager's experiential intuition. The benefit of the proposed approach is demonstrated through a case study.

Paper 50, Page 401-406

Project Performance Measurement: Implications of Current Trends on the Project Manager's Responsibility

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Abstract: The mix-up between project and business/corporate performance metrics remains a problem in project management. Using the construction case, and a comparative literature survey approach, it was found that some of the performance metrics currently required by clients are inconsistent with the project, and project management philosophy. Similarly, the said metrics attempt to extend the project manager's responsibility beyond the project and their use risk unrealistic and unrealized expectations and ultimately project failure. This paper concludes that using such metrics is uninformed, unsustainable and limited by strict contractual liability. The consistent invasion of project management by investment management principles via the use of such metrics requires sustained resistance if society is to protect project managers and benefit from managing by projects.

Paper 51, Page 407-411

Planning of Linear Construction Projects Using Geographic Information Systems

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Abstract: This paper presents potential applications of Geographic Information Systems (GIS) for planning and management of linear construction projects that are affected by the geographic conditions. Previous GIS applications in construction management area are reviewed. Potential applications are described using examples from a pipeline project. Benefits of GIS for planning and management of linear construction projects are discussed.

Paper 52, Page 412-419

A Solution for Developing the Algorithm of Transferring Cost Estimation Data to a CPM Program via Construction Management ERP Software

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Abstract: The main cause for poor execution of “Work Schedules” for construction projects is mainly related with the requirement of heavy data input on the CPM (Critical Path Method) software and the difficulties in data updates for each change on the project. We may summarize the primary cause for inadequate planning as being incapacity of access to the data.

As a matter of fact, the required data for CPM programs is covered in the cost estimation information of the construction work. The transfer of data entries to the CPM software through an algorithm and the right tool (software) shall make it easy to overcome the needless burden of data entry, which will assist the “Planning Professional” to focus on his/her main duties.

A cost estimation report takes place on every construction project, defining the work in quantities and the cost. On a cost estimation report, each production is defined with its item number, definition, quantity, unit price, location (detailed bill of quantity – BoQ).

In order to have a clear cost estimation report, a need for classifying production items may come out, based on their similar characteristics and their related building information.

Each production item of the estimation should take place as a resource belonging to related activities of the CPM schedule containing both cost and location information. Otherwise the project schedule is incomplete and most probably insufficient.

In other words; the data combined to develop the scope of the construction should be the same as the input of the CPM software. Only the formats may vary.

- The total cost information related to the activities should match the monetary amount of the scope of construction.

- If the productions are assigned to the activities as primary resources, the quantity and cost values belonging to these activities should match the cost and quantity amount of productions composing the scope of works.

In order to ensure keeping the same exact data, despite in different formats, both on CPM software and cost estimation, the quest to come up with an algorithm for this transfer has activated the practice and formed the solution exclusive for construction business.

Paper 53, Page 420-424

How Should Expertise Classification be Evaluated Within Construction Planning?

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Abstract: During my professional career which started on 1972, I have witnessed that “Planning Technical” personnel is judged by nothing else but his/her Primavera/MS Project skills. Most of the terms and functions in the scope of “Construction Management” should be reconsidered in line with the technology of the new millennium. It should be identified as a profession/expertise and it should be ranked or categorized. The term “Planning” is elementary component of construction management. Expertise level should be identified on CV documentation of the technical personnel who gained experience and marked a career path in accordance with this content. In order to create a brain storming within this context, my personal opinions are presented, as follows.

Paper 54, Page 425-435

Cost and Time of Construction Projects in Malaysia

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Abstract: In construction, cost and time are part of the project success indicators. Cost and time overruns are considered as common problem in construction projects. The extent to which construction projects in the Malaysian construction industry are experiencing cost and time overruns is currently unknown. An initial investigation has been undertaken by looking into the time and cost overrun of projects executed in Malaysia and to find out the relationship between the cost and time for a construction project. A questionnaire survey targeting quantity surveying consultants was conducted. The data was collected on 359 projects consisting of new build and refurbishment projects executed by the public and private sectors. The firms provide information on previous projects relating to: general information of the company, name of the projects, start and completion date, location, number of storeys, gross floor area for building projects, contractual and actual durations, pre-contract budget, contract sum and final account. The results of the data collection indicate the cost overrun of the projects ranges from -80.38% to 88.76% and time overrun ranges from -19.32% to 440%. It also suggests that time overrun in project delivery in Malaysia is more crucial than cost overrun. The relationship between time and cost for a construction project would be represented by the Bromilow equation ($T=KCB$). The results show that for the

construction projects in Malaysia there is no evidence to suggest that all the project parameters considered follow this relationship

Paper 55, Page 436-443

Application of a Heuristic Algorithm for Efficient Resource Scheduling: A Case Study

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Abstract: In the scheduling of construction projects, conflicts can arise when activities require resources that are available in limited quantities. Mathematical techniques exist for allocating resources whilst retaining minimum project durations. One such technique is 'LINRES', a heuristic algorithm devised by researchers at Northumbria University in the UK who demonstrated the advantages of LINRES over 32 existing heuristic rules, in trials on a hypothetical project (Abeyasinge *et al.*, 2001). Following this hypothetical test of the algorithm, the present paper reports on the live implementation and empirical testing of LINRES on a real project. The project was an important section of the Shariati Combined-cycle power plant, carried-out by the MAPNA Company in Iran: namely, the Heat Recovery Steam Generator (HRSG). Research was carried out to investigate if the LINRES algorithm could improve the scheduling of the HRSG construction, which took place in 2002. Data from the project were simultaneously subjected to manipulation by LINRES and by Primavera Project Planner, one of the most powerful software planning tools available on the market. Outputs were compared, and the performance of the LINRES scheduling tool was found to be superior in its ability to provide an acceptable trade-off between the resource aggregation profiles and consumption justified.

Paper 56, Page 444-453

Estimating Pavement Maintenance Costs under Performance-Based Contracts

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Abstract: Performance-based maintenance contracts differ significantly from method-based contracts that have been traditionally used to maintain roads. Road agencies around the world have moved towards a performance based contract approach because it offers several advantages like cost saving, better budgeting certainty, better customer satisfaction with better road services and conditions. Payments for the maintenance of road are explicitly linked to the contractor successfully meeting certain clearly defined minimum performance indicators. It is indeed a difficult task to estimate contract value of these maintenance works when no definite quantity of work is known. There is an abundance of literature when the objective function is to determine how much of the road section can be managed with the available funding. On the contrary, when the objective function is to determine how much money is required to maintain the road to certain specified performance conditions, there seems to be a dearth of knowledge. Estimating the value of these contracts based on the performance specified by the transportation agencies to maintain them over a certain period of time is the main aim of the research. For this, rather than evaluating the cost of maintaining the road based only on a single performance criteria such as pavement condition index, multiple performance criteria such as cracking, rutting and, roughness are taken into consideration in developing a model to estimate the cost of such maintenance contracts. Markov chain process has been utilized to model the stochastic degradation of the road condition over a certain period of time. Preventive and rehabilitative maintenance activities of varying amount are then proposed over the maintenance contract period so as to limit the distress condition within the specified threshold. Based on the proposed program of preventive and rehabilitative maintenance works over the period of the maintenance contract awarded to the contractor, cost is finally estimated.

Paper 57, Page 454-461

Unique Dashboard Needs of Construction Project Team Members

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Abstract: Performance metrics, such as cost, quality and safety, are units of measures that are used to monitor the execution of a construction project. Many researchers have studied this topic and identified a large number of performance metrics for construction projects. Utilization of all of these metrics to monitor a project can result in information overload for different team members in a project team, especially since neither all metrics are relevant nor they are important to each party. Hence, to minimize such information overload, it is necessary to understand specific performance metrics that each party prefers using. In order to understand varying metric needs of project team members we have conducted semi-structured interviews using dashboard concept as a way to distill important performance metrics useful for each team member of a construction project and hence to understand diverse dashboard needs of project team members. During these interviews, the interviewees design a dashboard by specifying which metric they like to see in what level of detail using what type of graphics in order to support their decisions. The results of this study show that each project team member indeed has unique requirements for what s/he would like to see on a project management dashboard, and hence there is a need for customization of dashboards to support those needs.

2.2 Procurement Management

Paper 58, Page 462-472

Botswana Construction Procurement Process: A New Approach

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Abstract: The construction industry in Botswana has been identified as low performing. Currently the Botswana government uses the design-bid-build process, using prequalification and award to the low bidder for construction services. The government can also use the design-build delivery system. The current delivery system uses an engineering group that delivers designs and construction, using a procurement group to award the contract and contract modifications. However, the analysis for all actions is done by the engineering group. Performance has not been good. The authors propose that the delivery system, the paradigm, and decision making by the engineering group causes risk to the project and results in poor performance. The authors suggest making modifications in the process and using design-build. The authors also propose to change the paradigm using best value PIPS/IMT concepts.

Paper 59, Page 473-480

Selection Criteria used for the Choice of Procurement System for Major Highway Construction Projects

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Abstract: In the project management process of the realization of major highway projects, the choice of procurement system is central to success as the relevant social environments of public infrastructure projects are numerous and with interdependent interfaces. Since highway projects cannot be considered as repetitive projects, a statistical analysis of performance of highway projects using various procurement systems would not lead to representative results, therefore, the research methodology chosen is dependent on opinions of experts in the field of highway project and contract management.

The procurement systems investigated are Traditional, Traditional Fast Track, Design and Build, Private Public Partnership, Construction Management, Management Contracts and Partnering. An extensive literature review showed significant research into procurement system selection models for buildings projects. Based on this literature review, the most common selection criteria for the most suitable procurement system as documented were chosen and a questionnaire was developed and distributed to experts in highway

authorities in Europe and abroad to rate the procurement systems against these criteria.

This paper presents an evaluation of the criteria most commonly employed by contract awarding authorities in the highway industry, both in Greece and abroad, in choosing the most beneficial procurement systems for highway projects.

Paper 60, Page 481-489

Procurement Selection Practices in Post Disaster Project Management: A Case Study in Banda Aceh, Indonesia

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Abstract: On the 26 December 2004, a great 9.2 earthquake jolted Aceh, Indonesia, followed up by an atrocious tsunami minutes later that wipe out some 200,000 lives in Aceh and thousands more across neighbouring countries. Millions of dollars worth of properties have been damaged and completely destroyed. Billions of dollars poured in, involving many Non-governmental organizations (NGOs) world wide to help out rebuilt affected areas. This study was carried out during the post disaster development phase involving several NGOs in the earthquake and tsunami stricken area in Aceh, Indonesia. The study focuses on the project management practice in adopting procurement method and its relation to the project performance during the reconstruction and rehabilitation period. The study involved five international NGOs that were actively participated in the reconstruction and rehabilitation projects in Aceh. Questionnaires were distributed to the employees for gathering information related to the study. Interviews were also carried out with project managers to verify relevant matters. Findings show that all the five international NGOs adopted the traditional procurement method. Factors influencing the choice of the procurement method were identified as timing, responsibility and the quality of work. The study also found that the chosen procurement method took longer time but it still employed by the

five international NGOs due to the easiness of monitoring many projects that have to be completed on time.

Paper 61, Page 490-497

Cultural Diversity and Its Effect on Construction Project Team Effectiveness

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Abstract: Dubai has become the destination of many multinational companies attracted by the buoyant construction activities. One of the main drawbacks of such business environment is the increasingly high competition between such companies to recruit and retain the needed human resources that have the desired expertise and skills. This led these organisations to recruit from wide and far increasing the cultural diversity of their project teams. Not surprising that diversity management is becoming an important management tool for the effective delivery of projects.

This paper reports a research that has investigated the cultural diversity phenomenon within construction projects in Dubai and its affect on project team effectiveness. The main aim of the paper is to assess the effectiveness of a culturally diverse project team and the effectiveness of project managers in dealing with such culturally diverse teams on construction projects. The paper reports the results of an empirical study into the relationship between the extent of cultural diversity and project team effectiveness. The empirical study was complemented by a series of interviews with senior managers and project managers. The findings of the empirical study suggest that there is no significant relationship between the degree of project team cultural diversity and their overall performance measure. However, the results showed that there is a negative relationship between the degree of cultural diversity and output, productivity, and efficiency (OPE). OPE being one of the main components of the project team overall effectiveness.

Paper 62, Page 498-506

Evaluation of How Construction is to be Procured in Next Ten Years in The 2010s

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Abstract: We have different understanding of procurement. One would easily accept the idea of tendering as project procurement as this is usually the way construction product and service are procured, and is so important because the process triggers off 'business' for contractors and consultants. The other would consider tendering together with contractual arrangements as procurement. So construction to be procured in the next ten years should extend to planning and to link together tendering and contracting by integrating the planners and the implementers to satisfy clients' needs and at the same time fulfilling the business objectives of the participants. This paper attempts to re-look at procurement via public, private partnership, supply chain management and benefit trading to review the 'purchasing' dimension as understood by the business schools. It discusses the public policy from a strategic direction and highlights the procurement focus in formulating procurement strategy. Two case studies are included to demonstrate how contracts are arranged to attain integration such that the clients' needs are fulfilled and the business objectives are met. A commentary for the case studies is provided and it concludes that appropriate leadership, committed workforce and adequate rewarding schemes are the success factors for project procurement.

Paper 63, Page 507-515

Procurement Strategies for the Oil and Gas Industry: Capturing Changing Values and Dealing with Multi Cultural Complexity

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Abstract: Global business trends have led the oil and gas industry to seek better solutions to overcome the emerging challenges and critical issues, such as the need for procurement strategies based on new

values and contextual factors including multi cultural complexity. One way to overcome some of these critical issues is perhaps to adopt new innovative approaches to suit different locations, countries or regions while trying to incorporate the differences in business philosophy, culture or values within the oil and gas organisation themselves into these approaches. These innovative approaches also need to accommodate specific project needs and different values either in the business philosophy or culture within the oil and gas organization themselves or in the local practices.

This paper will specifically look into important aspects of research processes, elements, methodology and approach which were conducted on the said topic. The aim of the main research study is to improve the understanding of procurement strategies of players and stakeholders (hereafter referred to as “decision makers”) in an industry that has gone beyond regions and boundaries. The objectives of the main research study included: to explore current procurement practices and trends; to identify the different values adopted by players; and highlight the possible impact of multi cultural complexity on global procurement process and strategies.

Among the key conclusions and recommendations that can be derived from the main research study includes the need to improve the current procurement process in the industry to achieve a more conducive, sustainable and fair working environment between clients and contractors. Finally, a comprehensive procurement strategy guideline on selection processes to be used by decision makers in the industry was developed and produced comprising a set of phases and critical steps that needs to be followed and performed during the selection process to assist decision makers to make better analysis and assessment on the appropriate procurement strategy to be adopted in future oil and gas projects throughout the world. This paper represents the summary of the main research study, its methodology, findings and conclusions.

Paper 64, Page 516-522

Utility Model for Evaluation of Alternative Procurement Methods

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Abstract: A major decision the owner of a facility project has to make during the planning phase is selection of a procurement method, as it will have a significant influence on the management and performance of the project. In addition to the traditional design-bid-build method, there are alternatives routes such as design/build and management contracting that may be selected. These methods have different strengths and weaknesses, and the selection must consider the nature of each method against the conditions of a project and the priorities of the owner, and the best method can only be found using an overall evaluation. Researches on applying decision analysis techniques to procurement method selection can be found in the literature, but they do not provide a quantitative analysis of project attributes, especially assessment of trade-offs between time and cost. This paper presents a multiple-criteria utility model for evaluating alternative procurement methods for a project according to estimated performance. The project duration and cost through each procurement route are estimated probabilistically and translated into utility values by utility functions. The utilities of other aspects including design quality and management of construction are also assessed. The weights of the criteria are determined using the analytical hierarchy process. The weighted total utility represents the overall evaluation of a procurement method. Case study involving a high schedule risk project of high complexity is presented to illustrate the proposed model. The results show that the model is sensitive enough to differentiate the effects of the system and organization of each procurement method in accordance with empirical expectations. Therefore, the model can serve as a decision aid for consistent evaluation of procurement methods

Paper 65, Page 523-532

Is it the Culture or an Unstable Procurement Model that Causes Nonperformance in Botswana's Project Management?

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Abstract: A research group at the University of Botswana is investigating how culture and construction delivery system stability affect construction industry performance. They are trying to increase the construction performance of the country in the quickest and simplest way. Currently, the Botswana industry is heavily dependent on foreigners. The researchers are trying to identify if the problem is the underdeveloped culture, or potentially the combination of culture and an unstable delivery system, and can a stable delivery system raise the culture of Botswana. The two potential areas of interest are the country culture, and the project delivery or management model. The authors are using deductive logic, simplistic models, and dominant or extreme information to minimizing the need to get into a long drawn out study of details which may not solve the issue. The objective of the paper is to identify the best method to increase the performance of the construction industry, addressing both the cultural and delivery system problems. The preliminary measurement of the success of the solution is the acceptance of the concepts by major users in Botswana. This paper will propose the potential solution then continue to test out the hypothesis for the next few years. If this solution is valid, it has tremendous potential in underdeveloped countries.

2.3 Project Management Issues

Paper 66, Page 533-542

Minimizing the Impact of Culture in Botswana on the Implementation of New PM Paradigms

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Abstract: It has been a “perceived” that a “different” culture has an impact on introducing and implementing forward thinking and advanced paradigms and project management models in developing countries. A research group at the University of Botswana (UB) is investigating whether culture in a developing country has an impact on the introduction and testing of new, innovative project management (PM) techniques; and if an impact exists, how that cultural impact can be minimized. The research is to identify if out of the box, progressive paradigms from more developed industries and countries such as the United States (U.S.) can be quickly introduced in a culture that is not as progressive. The UB research group has partnered with the Performance Based Studies Research Group at Arizona State University and the CIB TG 61 to test whether an innovative Performance Information Procurement System (PIPS) can be implemented, sustained, and a research platform built at UB in a very short period of time.

Paper 67, Page 543-552

Can Developing Countries Leapfrog the Project Management Technology of More Developed Countries

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Abstract: Developed construction industries in the US, UK, and Europe have battled to increase the performance of their construction industries. These more developed countries influence the underdeveloped countries. The underdeveloped countries hire academics, consultants and experts from the more developed countries to model their industry and practices. The author is proposing that the underdeveloped countries should not do this based on the low performance of the developed nation's processes, and use more efficient and effective practices that are based on logic, practices from other more efficient industries, systems with proven dominant or very high performance.

Paper 68, Page 553-560

Senior Housing in Finland – Case Tampere

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Abstract: The Finnish senior housing market will face fundamental changes in the future when the post-war baby boomers reach retirement age. We will need more new senior houses than at present, and the existing housing stock will need renovating on a significant scale.

The purpose of this paper is to present an overview of the current Finnish senior housing field. The paper does not present guidelines, but offers some incontrovertible facts and discusses some pertinent points. The first part of the paper is a literature review, which identifies the issues and supporting statistics. The paper studies statistics on the population and building stock.

The empirical data concentrates more deeply on the senior house market in the city of Tampere. The data has been collected by a questionnaire survey and analysis of statistics. The questionnaire was sent to all companies, associations and foundations that develop senior apartments in Tampere. The survey has been carried out by authorities in Tampere in November 2007, and it is analysed by the author of this paper. There were 56 respondents, and the response rate was 91%.

Several conclusions can be drawn based on the data. Firstly, the currently scarce number of modern senior houses and apartments will increase in the coming years along with the number of senior citizens. This trend will continue until 2030.

Secondly, we should develop new living concepts for senior citizens. These concepts should include services for the elderly and take into account the needs of dwellers. Thirdly, we need more renovation projects in ordinary apartments. Old, existing apartments should be refurbished so that they support the lives of elderly people.

Paper 69, Page 561-568

Profiling the Modern Project Manager

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Abstract: Civil engineering projects include several uncertainties and risks, due to the special characteristics of construction industry. Time and cost are two crucial parameters that could potentially lead to successful and conforming to regulations production of projects. In this highly competitive environment, the tasks performed by a project manager are of special importance to the well being and economic prosperity of construction companies. This paper is trying to examine and create a desired profile of the person, who is responsible for managing a construction project. Firstly, there is an effort to review all the tasks that a manager is involved in. Performance and efficiency of each task is related to a number of characteristics attributed to the personality and cognitive skills of the manager. This study investigates the implementation of selected psychological instruments and inventories to a number of professional project managers. Furthermore, this study highlights the importance of psychological assessments in facilitating the procedure of selecting the appropriate person for a highly demanding managing position in a

construction company and delineates many of the required characteristics that constitute the profile of the successful project manager.

Paper 70, Page 569-576

The Attributes of Malaysian Construction Clients during Briefing Process and Factors Influencing Them: A Comparison between Public and Private Clients

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Abstract: The paper presents the findings of the 37 semi-structured interviews and the questionnaire survey of 104 consultant architects who involved in the public and private projects. The finding highlighted the current performances of client's attributes during briefing process and factors influencing them. Three categories of clients attributes were investigated namely, quality of client's representatives, brief management efforts and commitment of client's organization. A comparison was made between the public and private clients on similar situational factors of type of client, nature of the project and quality of design team that influencing their attributes. The paper concludes with significant variables that influenced their attributes and recommendation for the clients and design team to improve the client's attributes during briefing process.

Paper 71, Page 577-582

Better Understanding of Project Management for Small Contractors in Malaysia

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Abstract: Project management is a carefully planned system that applies knowledge, skills, tools, and techniques and utilizes resources in order to achieve a specific goal. Through implementation of

project management in any project, it will allow full utilization of resources, reduce cost and money, and eventually will contribute towards the success of the project. But, failure in the organization to implement such system will likely contribute to the failure in the project subsequently. Project management actually had become an important essence towards the success of any aspect in life. Questionnaires survey were sent to Class F Contractor in Malaysia and found that these contractors do has high degree of implementation of PM in their projects. It was found that they implemented project management in their organization by using various project management tools with the utilization of a very minimal amount of manpower and cost. It was found also that there are various differences in their implementation which is in the form of their organization structure, manpower involved, cost allocated and standard guidelines for the implementation that they possess.

Paper 72, Page 583-590

The Variables that Influence the Attributes of Malaysian Construction Clients during Briefing Process

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Abstract: Active participation of clients during briefing is important for accurate development of strategic brief which essential for successful implementation of construction project. The client's participation is depending on their attributes during briefing which likely to be influenced by many factors. This paper presents the findings of the questionnaire survey of 104 consultant architects who involved in the construction project in Malaysia. The finding highlighted the variables used to measure the attributes of Malaysian construction clients during briefing process and factors influencing them. Three categories of client attributes were investigated namely, quality of client's representatives, brief management efforts and commitment of client's organization. Situational factors of types of client, nature of the project and quality of design team were the main variables identified as influencing factors of client attributes.

The statistical tests were carried out to identify significant variables that influencing clients attributes.

Paper 73, Page 591-598

Critical Success Factors (CSF's) of Public-Private Partnership (PPP) Infrastructure Policy and Implementation: A Case Study in Philippine Road Sub-Sector

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Abstract: This paper looked at various research studies and papers and delved into an in-depth investigation of the issues, concerns as well as challenges that confront the Philippine Public-Private Partnership (PPP)/Build Operate Transfer (BOT) experience in the transportation sector's road sub-sector. The paper highlights the fact that there is no definite study conducted by the government on the most applicable and implementable risk mitigating measures that would serve as Critical Success Factors for PPP/BOT in the Philippine setting.

Primarily through a cursory review of the existing PPP/BOT contracts consolidating international generated risks and success factors and validating it through survey questionnaires, review of case studies and structured interviews from the key players of Philippine PPP/BOT system. The paper through its review of existing PPP/BOT contracts in the road sub-sector, will stress on the need to properly identify, allocate and mitigate risks attributed to infrastructure development under a PPP arrangement. From there, it will determine and recommend critical success factors in PPP/BOT policy and implementation in the Philippines given infrastructure development risks prevalent in the country.

Paper 74, Page 599-609

A Framework for Strategic Management in Construction Contracting Firms – The Case of Pakistan

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Abstract: This paper is an attempt to assess the strategic management approaches currently adopted by construction contracting firms in Pakistan as well as to highlight the key strategic areas by analyzing the current practices. The core objective of the paper is to propose a framework for strategic management for construction contracting firms in Pakistan. The methodology of the research includes investigating the common strategic management areas through literature review and interviews with selected contracting firms, conducting a questionnaire based survey and performing statistical analysis to validate the key strategic areas. These areas are evaluated on the basis of prevailing practices in contracting firms. A framework has been proposed for strategic management in local construction contracting firms. The significance of this research is that the construction contracting firms in Pakistan can build their capacity in the right strategic direction by considering the findings of this research study, which will make them increasingly competitive.

Paper 75, Page 610-617

Relationship between Partnering Process in Construction and Customer Satisfaction

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Abstract: Partnering Process in the construction sector is generally known as very simple and beneficial progress, which mainly aims to bring

success for all the participants that take place during the project. Human factor and systematic working environment is observed as important components of the success of the partnering process. Individualistic characteristics of the human and dependency of systematic working environment toward human attitude leads a research necessity towards the human factor upon Partnering progress. When the studies over human characteristics have been generally observed, various researches have showed that emotional characteristic of the person has huge effect on the decision mechanism over the cases. Customer satisfaction is one of the cases that have been stated in various researches which try to explain market conditions according to human decisions and their triggering points. When these factor's above considered its clear to see that there could be a relationship between Customer Satisfaction and Partnering Process in Construction. It is observed that the mutual relationship between the cases will either lead a successful cooperation in long term or unsuccessful ultimate point of the relation when the specific requirements and characteristics of the concepts have been taken into account.

Paper 76, Page 618-624

Factors Affecting Marketing Success for Construction Companies in the Housing Sector

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Abstract: Marketing is a critical issue to success in today's increasingly competitive business environment. A company's growth and success can be strongly influenced by marketing practices. The aim of this study is to investigate the critical factors affecting marketing success of construction companies in the housing sector. Within this context, a survey was carried out among 40 Turkish local construction companies that are operating in the housing sector. In this survey, top-level managers and owners of the companies were interviewed. The majority of the interviewees were the owners of these companies. The interviews were performed between January and March 2008. In the study, the survey questionnaire was administered during face-to-face interviews. The factors considered in this study were identified based on a

literature review. Then, a total of six possible factors that were felt to have an effect on successful marketing for construction companies in Turkey were determined. Finally, the ranking of the critical factors has been determined by using the Simple Multi Attribute Rating Technique (SMART). Based on the results, company image and customer satisfaction were determined as highly vital factors for successful marketing in construction business.

Paper 77, Page 625-632

A Striking Case Study in Respect to the Construction Project Management Aspects of an Ongoing Large Scale Industrial Construction Project

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Abstract: This paper highlights the extraordinary difficulties and resulting impacts in respect to the organization, overall management, logistics, and equipment and manpower supply encountered during the implementation of a large scale industrial construction project involving very stringent Safety-Health-Environment-Security (SHES) and QA/QC requirements and tight completion schedule under the unfavourable climatic conditions of Qatar including the impacts of unprecedented events and circumstances to the smooth and proper implementation.

The project is located at Ras Laffan Industrial City (RLIC), about 80 km north Doha, Capital of Qatar. The scope includes the execution of civil works, steel structure and equipment erection, pipe prefabrication and installation, painting, insulation and Electrical-Instrumentation (E/I) installation of Utilities, Offsite and Offplot of Train-6 and Train-7 Facilities of Natural Gas Treatment Plant. The progress is about 63% and manpower available at site is about 7,200 as end of December 2008. The peak manpower is foreseen as about 8,500. The overall direct manpower to be spent is expected to be more than 33 million manhours. The revised scheduled completion is end of 2009.

The measures taken and put into effect in order to mitigate and/or overcome the above mentioned impacts to the project execution to the maximum possible extent have also been presented.

Most important than all above, the lessons learned, worthwhile to be emphasized are concluded for similar cases.

Paper 78, Page 633-641

Evaluating Innovation Performance of Countries in the Construction Industry by Using Patent Data

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Abstract: It is a difficult task to evaluate innovation performance in the construction industry. Various metrics are used to measure innovation performance, such as research and development (R&D) expenditure of sectors, number of R&D personnel by sector, surveys and patent statistics. Among these metrics, patent statistics is one of the most commonly used data for evaluating the innovation performance in other industries. However, there are not any recent research studies that investigated patent activities in detail for the construction industry. In the study explained in this paper, it is aimed to evaluate and compare the innovation performance of countries and innovative firms in the construction industry over the years by using patent statistics. The international patent data was retrieved from the database of World Intellectual Property Organization. To filter the international patent data that is relevant to construction industry, international patent classification (IPC) symbols of patent applications were used. To investigate the accuracy of using IPC symbols for construction industry, concordance tables of WIPO and Maastricht Economic Research Institute on Innovation and Technology (MERIT) were applied to patent statistics. The results show the patterns of innovative activities among the construction firms, and countries, and in the industry. Also, the limitations of using IPC symbols to evaluate innovation performance of construction industry were discussed.

Paper 79, Page 642-649

Visual Management – A General Overview

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Abstract: Visual Management has been evolving and effectively employed in some manufacturing and service organizations for a long time. It is an essential element of the lean production system that can be approached from different scientific disciplines as well. The aim of this paper is to present a general overview of Visual Management, covering its definition, distinct attributes, brief history and identified functions within an organization. The anticipated future directions of Visual Management and the past research efforts, related to this field in construction management, were also discussed in detail. An extensive literature review and an analysis of the findings were performed accordingly. The necessity of a better understanding of how to effectively implement Visual Management in the construction environment was noted as an important future search opportunity.

Paper 80, Page 650-658

Managerial Competencies of Construction Managers

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Abstract: The construction industry differs from other industries due to its ingrained culture, unique nature, working conditions, and project-based setup. Besides technical issues, professionals in the construction industry also need to handle managerial issues. Therefore, professionals in charge of construction projects need to be in possession of management skills. Do the construction managers currently involved in construction projects exhibit the characteristics to be expected of a professional manager in this field? This study aimed to evaluate the managerial behaviors of active construction managers by administering a competency assessment test to a sample of construction managers and comparing the results with managers employed in industries other than construction. The Management Development Questionnaire (MDQ), a well-established and popular tool was used for this

purpose. A total of 63 responses were received. The respondents were assessed in 20 different competencies. The results indicated that the responding construction managers scored slightly below average. This may be an indication that a more rigorous training of construction managers could benefit the industry.

Paper 81, Page 659-666

Measuring Construction Innovation

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Abstract: Innovation is a complex and multidimensional process that has received the attention of researchers in all fields due to its contribution to economic growth and competitiveness. Innovation in general terms is the creation and adoption of new knowledge to improve the value of products, processes, and services. Although there are numerous studies investigating the implementation and management of innovation in construction, more research is required to develop appropriate metrics for different types of innovative activities that are carried out throughout the lifecycle of a construction project and at different sectors of the construction industry. Innovation in construction generally tend to be process and organization-based; construction companies invest less in R&D but rather adopt new technology and new ideas to improve their operations. Therefore, such innovations are difficult to capture with the standard indicators used for technology-intense sectors. The major objective of this study is to discuss the difficulties associated with measuring innovation in construction and provide recommendations to overcome the limitations for developing relevant metrics. In this respect, the appropriateness of metrics used for construction innovations will be investigated and how these metrics can be improved will be discussed.

Paper 82, Page 667-672

The Leader, The Led & The Mission: Their Impact on Project Leadership Performance

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Abstract: The study recognizes the importance of the project manager's leadership role in delivering successful projects. A review of literature shows that several studies have been conducted concerning the factors that impact on project performance and that leadership factors have been cited by many as important for project success. This paper focuses on the impact of various leadership factors on leadership performance in construction project management. It therefore contributes to the understanding of the influence of leadership issues in construction project management. Findings from a questionnaire survey, concerning the relationship between various leadership influences and project leadership performance, are presented. Project leadership was measured under three categories the leader, the led and the nature of the mission, while project leadership performance was measured qualitatively by the satisfaction of the project manager with project outcomes. Data used to explore the relationship was extracted from a project management study that explored the impact of project management process quality variables on project performance. The findings suggest that there is generally a small to medium correlation between the leadership factors and project manager satisfaction with performance. However, of the three variables [the leader, the led and the mission] the project mission

Paper 83, Page 673-681

Lean Construction Principles, Prerequisites, and Strategies for Implementation

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Abstract: The construction industry's inefficiencies and need for improvement are well documented. Research has pointed to an incidence of waste in the

vicinity of 30%, due to a variety of losses including workforce underutilization, cost overruns, late delivery, safety-related incidents, and construction defects. As the annual value of construction worldwide is approximately US\$4.0 trillion, the potential for savings in that industry is indeed great. Several researchers (Howell, Ballard, O'Brien et al) have shown that lean construction techniques reduce supply chain losses, reduce construction costs and shorten project delivery schedules. This paper addresses lean principles, the prerequisites for a lean construction environment, and provides specific strategies for successful lean projects. It will explain how these strategies improve projects in terms of cost, schedule, safety, and quality.

Paper 84, Page 682-693

Quantifying the Criteria for Performance Appraisal of Project Managers in Pakistani Construction Industry

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Abstract: Assessing and benchmarking the expectations of the primary construction industry stakeholders (owners, architect/ engineers and contractors) from the project managers is a key management function for motivating and developing professional project managers. This research explains how the design and implementation of an effective performance appraisal system will improve project managers' performance in the construction industry. It also attempts to obtain consensus

performance measures relevant to project managers in the Pakistani construction industry, and to rank their relative significance. Fourteen (14) evaluation measures for a project manager were developed via extensive literature review and expert interviews from a selected cross-section of local industry representatives. Next, a structured questionnaire was devised and administered to allow a broad cross-section of industry stakeholders to assess and rank the relative importance of these measures. "Achievement of planned, agreed objectives" received the top priority as a performance evaluation measure for project managers. The fourteen (14) measures were further analyzed and categorized into six areas that were considered by the industry stakeholders as the most determining areas in which they would like the performance of their project managers measured. "Personal traits" represented over 40% of the preferred performance measures. The study emphasizes that the rankings of the importance of skills can be a guide in the training of project managers both at the level of pre-qualification as well as post-qualification. They can also be used as a yardstick in evaluating a would-be project manager during interview and final selection.

Paper 85, Page 694-701

Ranking Construction Superintendent Competencies and Attributes Required for Success in Pakistani Construction Industry

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Abstract: Success of a project is the responsibility of construction team leaders, project manager and superintendent. The construction job superintendent is like the conductor of a symphony orchestra. He must see that all elements are fitted together at the right time and sequence. This construction conductor is responsible for the on-time and within budget completion of construction projects. The superintendent plays a key role in the completion of the built environment. He is responsible for the direct daily supervision of construction activities on the project, whether the work is performed by the contractor's workers or those employed by subcontractors. It is his responsibility to coordinate labor, material, equipment and subcontractors during construction. Since the superintendent has a key role in the success of a construction project, the competencies (skill sets) and attributes that make that individual successful are very important. This research attempts to identify and rank the key competencies and attributes needed in a construction superintendent that make him successful. Results indicated that leadership, time management, ability to plan ahead, understanding subcontractors' work, and ability to work with different kinds of people are the top ranked skills for construction superintendents. It is emphasized that ranking the key superintendent competencies and attributes would help in the development of appropriate training programs for construction superintendents as well as providing a mechanism for contractors to improve key superintendent skills in order to achieve successful projects.

2.4 Project Delivery Systems

Paper 86, Page 702-709

Communication of Constructability: A Comparative Analysis Between Design-Bid-Build and Design-Build Delivery Methods

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Abstract: Project Constructability represents the ease of transforming the design into a constructed facility in accordance with the owner's objectives. This requires great construction knowledge/experience integration throughout the early phases of the project life cycle. Effective coordination and communication between designers

and constructors is then essential especially during the design phase. This paper aims to identify the optimum delivery method that enables the integration of the required construction knowledge/experience during design development and hence producing a design with minimum constructability problems. Available delivery methods provide a matrix of organization with formal and informal relationships between the participants. Depending on the delivery method, the communication model changes, and thus the potentiality, to integrate the needed construction knowledge and experience into the design, varies. The paper first presents the problem of developing a constructible design with its causes and impacts. Then, the paper briefly presents the traditional Design-Bid-Build and the Design-Build delivery methods as they are currently the two most widely used delivery methods. The paper compares how project participants communicate together, and how communication of constructability issues is being handled in each approach. Finally, the paper identifies which delivery method is optimum for improving design constructability.

Paper 87, Page 710-717

Adopting a New Housing Delivery System: The Case of Private Housing Developers in Malaysia

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Abstract: For the last 50 years, the housing delivery system in Malaysia has been based on the Sell Then Build or buying off the plan system. A host of problems, such as abandoned projects, unsold housing, late delivery, and shoddy workmanship, have put pressure on the industry to implement of a new housing delivery system to achieve better housing quality and to promote greater prosperity in the housing industry. The aim of this paper is to examine the factors that affect the adoption of a new housing delivery system (the Build Then Sell system) from the viewpoints of private housing developers. Resource-based Theory was utilized in order to examine the capability of private housing developer firms to adopt the BTS system. Possible factors that affect the different levels of Build Then Sell adoption among housing developers were investigated. Using a structured questionnaire and

in-depth interviews, data were collected from housing developers located in the major Malaysian cities; where there are many activities conducted by private developers. The findings indicate that factors affecting the adoption of the new delivery system include firm characteristics, types of financial resources, organizational culture, and developers' concerns. The findings also reveal an important factor to help facilitate the adoption of the new delivery system.

Paper 88, Page 718-723

Public Private Partnership Model for Airport Investments in Turkey: The Case of Ankara Esenboğa International Airport Build Operate Transfer (BOT) Project

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Abstract: Airport privatisation in the world has evolved since the 1980s from the outsourcing of services to public private partnerships. This evolution has been necessary because the demand for aviation has been in a state of constant growth and will continue to grow indefinitely. The privatization of airports in Turkey follows the same trend as in the world beginning with public-private partnership (PPP) model executions. This paper aims to give a brief history on privatisation in the world and in Turkey and sets out to look at the successful case of Ankara Esenboğa International and Domestic Airport BOT Project.

Paper 89, Page 724-731

Influence of Project Delivery Methods on Achieving High Performance, Sustainable Buildings: Preliminary Results Based on a Pilot Study

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Abstract: Growing environmental awareness has resulted in the increased global demand for high performance sustainable buildings. Such buildings are recognized by green building assessment systems, which certify a building as environmentally responsible, energy efficient, and a healthy place to inhabit. However, on the assessment scale, the factors lining the level of sustainability achievement are mostly product based. They do not consider the level of team integration in project delivery processes, which has been shown to result in optimized project outcomes, and increased value to the owner with maximized efficiency. Projects are typically delivered through design-bid-build, construction management at risk, design build, or a variation of these methods. These project delivery methods (PDM) facilitate various levels of team integration in building projects. Therefore, project stakeholders such as owners, government, architects, engineers, constructors and industry must understand the influence that PDM's have on achieving sustainable goals in buildings. This paper presents the results of a pilot study in pursuit of this investigation that helps to select the study metrics to understand project sustainability outcomes and measure the level of team integration in project delivery processes facilitated by different PDM's. The paper also presents the case study selection criteria and potential respondents from project teams to guide this research in data collection and analysis stages. The lessons learned of the pilot study are also presented.

2.5 Safety and Quality Management

Paper 90, Page 732-739

Policy, Practice, Education and Research Issues in Designing for Safety

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Abstract: Design is a complex process involving several stages from conceptual design through to construction and commissioning. In this process, the design is checked and passed to different people who may further pass it on to others for integration. Designing for safety can reduce injuries and fatalities on construction sites. This paper reviews the designing for safety concept and alternatives on policy, practice, education and research and suggests which issues should be developed by designers, safety practitioners and researchers. In order to better understand the concept, policy, practices, education and research issues are examined with a view to designing for safety and health in general and with particular emphasis on construction. The study concludes that safety will improve provided designing for safety is adopted and policy, practices, education and research issues are embraced and developed.

Paper 91, Page 740-747

Modeling Three-Dimensional Space Requirements for Safe Operation of Heavy Construction Equipment

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Abstract: The organization of space on construction sites is one of the main concerns for safety managers. Space is often limited and critical resource, since it is constrained by competing work crews, flow of materials, movement of equipment, and temporary facilities and other structures. Planning for efficient and at the same time safe site space utilization is a challenging task. This paper presents a framework for defining safe space requirements for construction activities, and will focus on heavy construction equipment. It extends previous research on determining construction activity workspace requirements by concentrating on the following three issues: (1) Identification of equipment operating space requirements and generation of equipment operating areas and volumes; (2) Measurement of spatial requirements for safe work environments; and (3) Development of an equipment selection tool based on work site constraints and safety. This paper will separate the operating space of construction equipment as a representation of a number of layers, such as equipment space, work space, rotation space, maximum reach space, and safety space. Such layers will allow to account and plan for possible interference with other objects or different layers of other resources (personnel, equipment, and materials). The presented framework is implemented using an existing database that allows the selection of equipment based on its scheduled activity in a construction project. An efficient tool for construction safety managers is presented that identifies equipment space requirements for a safe construction project and can be easily integrated with other space planning tools. Furthermore, field experiments and results using emerging real-time pro-active proximity sensing and warning technology in conjunction with work crews and heavy construction equipment is presented that helped in defining and calibrating the spatial needs and requirements of heavy construction equipment

for the developed space planning tool. As a result of this work, site layout planning for safe heavy construction equipment operations becomes feasible.

Paper 92, Page 748-756

Demolition Within Congested Urban Environment – Nature of Risk and System to Ensure Safety During Work, the Hong Kong Cases

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Abstract: Demolition is one of the dangerous operations in construction in particular working within congested urban environment like Hong Kong. Demolition is often carried out in close proximity to existing buildings, busy streets, sensitive slope, or even adjacent to large and complicated underground facilities such as subway station, railway tunnel or buried city services. Buildings to be demolished can also be very critical, such as of very high-rise nature, with very long span elements and high headroom, or incorporated with special structures like high-strength concrete, tensioned, precast, composite or structural steel members. In some extreme cases, the building to be demolished consists of a deep basement itself. Demolition process under these situations can hardly be performed all without human operatives. The kind of health and safety uncertainty that workers faced when getting into such work environment can easily be understood, needless to mention other disastrous consequences that may cause to third parties. This paper tries to highlight various kinds of risk and dangerous work environment that undermined during demolition within congested urban environment.

Paper 93, Page 757-765

Social Costs of Construction Accidents and Safety Investments in Hong Kong

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Abstract: Financial costs of a construction accident are those costs which are borne by the employer of the victim as a result of losses from the accident. Financial costs are, however, are fraction of the social costs which are borne by the society as result of loss in the economic activity in the society and for providing rescue/support services/facilities to the victim. In addition to the accident costs, there are preventive costs called as safety investments made by the contractors and the related public sector organizations. In this paper, the cost data of 406 accident cases on 87 construction projects in Hong Kong from year 2005 to 2007 have been analysed along with the accident cost and safety investment data from 23 organizations. The data for accident costs from contractors was normalized to reflect the overall society. The results show that there was a gradual increase in the safety investments as a fraction of overall construction output in Hong Kong from years 2005 to 2007 whereas social costs of accidents expressed as fraction of overall construction output gradually decreased in those years. Overall, there was an average of \$1.30 decrease in the accident costs with an extra \$1.00 on safety investment with respect to the previous year.

Paper 94, Page 766-773

An Assessment for Safety Management of Construction Plant and Machinery in Malaysia

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Abstract: Within these past few years, the Malaysian government has made an effort on executing safety and health policies through the enforcement of guidelines as well as conducting site safety seminars and certifications. Ranked as a second industry in Malaysia that contribute to highest percentage of accidents at the worksite, the impact of loss of profit and unhealthy workplace affect the construction industry. Statistic from research by Social Security Organization (SOCSO) has shown that construction plant and machineries becomes one of the caused for the accidents. Hence, this seminar which titled “Safety Management of Construction Plant and Machinery” tries to delineate the relationship and the importance of safety management for construction plant and machinery by designing and proposing an application model that can be used as guidelines for the management. Knowing that ‘safety management’ is a new management concept in Malaysia, this paperwork aims to determine the extent of safety management in Malaysia and to initiate basic concept that can be logically implemented for the management of construction plant and machinery. Myriad adjustment which requires a long process and time will procrastinate the empowerment of safety management for construction plant and machinery within a short period of time. Therefore, a proposed model which is also a framework is seen as a procurable method on defining the basic concept of safety management for construction plant and machinery. A basic management application model as suggested by Walker (1993) is proposed to be used as a generic model to highlight the key features.

Paper 95, Page 774-781

Investigate the Cyclical Style of Safety Management Utilizing the Construction Safety Culture Dynamic Model

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Abstract: The major cause of construction accidents is viewed as the direct result of having a poor safety culture. A better understanding of how to improve safety culture greatly assists an organization to allocate appropriate safety resources, and improve its safety performance. This paper develops a construction safety culture (CSC) dynamic model, based on a widely used EFQM Excellence model, to capture the interactions and causal relationships among the key enablers and goals of CSC, over a period of time. The CSC index, developed through the CSC dynamic model, is used to measure the current CSC maturity level of the organization. The cyclical style of safety management is also modeled, through the CSC dynamic model, to reflect the situations where management withdraws attention from safety, which then leads to a reduced CSC index.

Paper 96, Page 782-788

Noise Exposure of Construction Workers

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Abstract: Publication and acceptance of standards or directives relevant with the monitoring of noise in a construction site seems still not sufficient for the hearing and health conservation of the workers. It is now well known that the lower and upper noise action levels have to be respectively 80 dBA and 85 dBA. What is still not well established is the use of hearing protection devices, HPD, and the keeping of health follow-up records. In order to display the current conditions, two construction sites, namely an in-city construction site of a contractor and a state construction site are chosen. The working habits of the workers are observed and L A e q values are measured at the ear level of the operators. The L A e q values corresponding to the operator of the front

loader (tracked excavator) was 93 dBA (79.5 dBA). The workers near to the excavator were exposed to a noise level of 75.6 dBA. None of the workers had worn HPD. The noise spectra are observed to contain Low Frequency Noise, LFN.

Paper 97, Page 789-795

Resource Allocation for Strategic Quality Manangement: An Analytic Network Process (ANP) Model

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Abstract: Recent research attempts emphasize that Total Quality Management (TQM) is a combination of two broad categories of elements: hard elements and soft elements. Many academicians believe that there is no commonly accepted framework for TQM. This is due to the complexity of identifying the base from which the soft and hard elements of TQM are defined. This paper views Quality Management (QM) itself from a perspective that allows for resources to be the base by which QM operates. Thus, it deals with QM from a strategic point of view, or what is known as Strategic Quality Management (SQM). The Analytic Network Process (ANP) is, used herein, to model the interactions between eight SQM strategies (identified in the literature as critical), and their resources. The case of two different companies is investigated to show how the interaction between strategies and their allocated resources differs due to the nature of business, product and history.

Paper 98, Page 796-801

Quality Management in Architectural Projects: Imperatives on Architecture /Construction Community

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Abstract: Architectural projects are complex and so is the issue of quality in them. Involvement of several participants with varied interests and heterogeneity of construction process are major factors that impede quality of a constructed project. The globalisation of business activities has significantly altered the quality norms in architectural and construction projects. Today, the clients and developers are better informed of international quality standards. The challenge before the architecture/construction community is to rise to the expectations of their clients by adopting the business practices that can deliver quality. Though, architecture/construction community in India has demonstrated their capabilities to deliver quality, there are areas for improvement and need for a structured formal approach to quality.

This paper is an attempt to investigate in to the various activities and processes during design development phase that influence the quality of a constructed project. The authors have undertaken the study of design development processes in twenty architectural firms in India with an objective to assess the adequacy of the prevailing practices in meeting the quality needs of the clients and to identify areas where architecture/construction community needs to focus to overcome the causes that impede the project quality.

Paper 99, Page 802-810

Quality Culture Auditing for Construction Contractors in Pakistan

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Abstract: Quality management has been one of the research focuses in construction management for at least two decades and extensive literatures have been written in areas related to the quality of construction works. Most agree that a change in culture, or a creation of a quality culture, is the key to the success of any quality initiatives made by contractors. To achieve cultural change, one must be able to measure the magnitude of any change, positive or negative, against a pre-determined benchmark. In other words, the existing quality culture of a contractor must first be audited so that it can be used for further reference. Through the use of a Quality Culture Auditing (QCA) questionnaire, this paper develops a pragmatic tool enabling construction contractors to measure the quality culture quantitatively using a scoring system. A total of 42 construction contractors completed the QCA questionnaire and the scores obtained were analyzed. The results indicate that QCA can be used to reflect the existing quality culture of a construction contractor, who can hence make improvement on the areas which are weak as indicated by the QCA.

Paper 100, Page 811-819

Quality Function Deployment Methodology for Evaluating Customer Satisfaction in Mass Housing Sector

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Abstract: Along with the concept of globalization, the competition among the world markets has become stronger and as a result, customer satisfaction has become the most important way for companies to differentiate themselves from their competitors. Thus, the companies must accurately determine the customers' needs and requirements in order to achieve perfect and permanent customer satisfaction. Supposing that the performance of a mass-housing producer could be evaluated by customer satisfaction, it is explored what percentage of the customers' needs and expectations has been concerned and adapted in accordance with today's mass housing trends. With the guidance of this evaluation, the applicability of the Quality Function Deployment (QFD) methodology to mass housing sector has been questioned and a sample model has been proposed for its adaptation to the sector. Within the context of this study, an attempt has been made to contribute to developments pertaining to the adaptation of QFD to the construction industry. For this purpose, a strategic focus group representing the potential mass housing customers has been composed and a research has been carried out with this group to collect and process data concerning their basic requirements and expectations. The finding of the study has demonstrated that the companies in the mass housing production market can considerably benefit from this methodology. As a result, despite some limitations and challenges, QFD has been observed as a very flexible and adoptable tool for mass housing producers, while evaluating the expectations of their potential customers.

Paper 101, Page 820-823

Built Quality Evaluation Case for Hotel Buildings in Turkey

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Abstract: A study of built quality evaluation in 12 quality hotels in Turkey has been carried out and the results are reported using a site survey in 2004. The breakdown of quality deficit areas showed that design mistakes and technical problems dominated on the total ratio. A number of factors that affect renovation need of hotel buildings, such as age, fashion, technical imperatives, etc., are reviewed and the difficulties in assessing hotel building quality performance are pointed. Finally the problem areas of built quality, and reasons for renovation are presented as an outcome of the research.

Paper 102, Page 824-831

Socio-Economic Influences on the Adoption of Total Quality Management in the Libyan Construction Industry

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Abstract: The Libyan construction industry has evolved significantly in recent years and this paper sets out to explore the socio-economic influences that may present barriers to the wider adoption of quality management practices in the Libyan construction industry. Building on established paradigms of Total Quality Management (TQM) and empirical evidence from a survey of two Libyan construction companies, this paper presents a quantitative measure of TQM practice within the Libyan construction sector and outlines proposals to enhance future practice. The outcomes from this research are threefold. The first is a conceptual model for TQM that draws together threads of academic theory into a unified framework for analysis and which will be of interest to academics and researchers. The second is an assessment of TQM knowledge and understanding within the construction sector of Libya, which international businesses with an interest in engaging with the construction process in Libya will find of significant value. Thirdly the paper identifies socio-economic influences that have acted to help or hinder the adoption of TQM practices within the Libyan construction industry and proposes ways of addressing the issues raised.

Paper 103, Page 832-839

Investigating the Cost of Quality in Construction SMEs

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Abstract: This paper is based upon empirical research conducted within the UK SME construction sector. It appertains to an investigation into the perception of quality and how it can be realistically costed by UK SME construction organisations. It is important to be able to quantify the true costs of a 'quality driven agenda', as this can have a bearing upon the strategy an organisation adopts in relation to the quality issue. Part of the empirical research was based upon a case study, supported by questionnaires sent to a sample selected from UK construction companies and incorporating interviews. One also needs to be able to differentiate between 'quality costs' at the design and construction phases, this aspect forms part of the study. The conclusions drawn will have valid transferability for SME construction companies in the wider European context, as the basic principles of costing are the same. The proposed outcome of the paper is to provide a valid rationale for the attainment of quality costs and further to provide a suitable evaluative model for utilisation by other European construction companies.

2.6 Legal and Contractual Issues

Paper 104, Page 840-850

A Study on Malaysian Legal Framework and Risk Management: Design Works

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Abstract: The construction industry is subject to more risk and uncertainty than many other

industries. Construction projects are associated with various aspect of risks, be it risks associated with the feasibility stage, design stage, construction stage and post construction stage. This paper is meant to address two main concerns. The first objective is to identify the understanding of Malaysian architects on risks related to design and the management of such risks. Secondly, this paper will look into the architects' apprehension on laws corresponding to the notion of proper risk management framework. A set of questionnaire was sent to the respondents; the PAM registered architects, with the view of securing data from the respondents on risks related to design, risk management and the PAM standard form of building contract and the general law on design risk management. The findings will be analyzed in contrast with the theoretical framework derived from the literature reviews on design related risks, risk management and the law.

Based on the replies received, the respondents, irrespective of their years of experience and frequency in dealing with the PAM 1998 Form of Building Contract (PAM 1998) agreed that there are risks involved with design works. These risks must be properly addressed to ensure the success of the project. In addition to that, most of the respondents agreed that the risks originated from the same sources. The respondents also agreed on the scope of their duty to be fully scrutinized in order to avoid risks. However, while most agreed on the basic element of risk management, mix views were evidenced on risk response method. With reference to the legal framework, most respondent understand the laws regulating their duties and generally accept the law as an important risk management tools. Nevertheless, respondents misconception of the law as well as the insufficiency of the legal provisions itself pertaining to architects and design works may defeated the whole purpose of establishing a proper framework for risk management.

Paper 105, Page 851-858

Delay Analysis Techniques Comparison

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Abstract: Many techniques have been used in the courts to demonstrate the criticalities of a delay event on the project schedule. At this time, there is no standard method to analyze a delay claim. This paper first introduced a fictional case study that has most types of delay and acceleration events that might be faced on a real project. The case study is applied to all current techniques of delay claims that have been identified from previous studies. The comparison uses the delay claim issues as criteria to evaluate all the delay claim techniques from the case study results. The case study result and discussion demonstrate that the Day-by-Day technique satisfies all the desired criteria while other techniques lack some.

Paper 106, Page 859-865

Comparison of Saudi Public Works Contract versus the UK Counterpart

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Abstract: Recently, Saudi Arabia has become a member of World Trade Organization (WTO) after undertaking major revision in many laws and regulations. Simultaneously, Saudi Arabia is required to redraft other major laws including Public Works Model Contract in order to comply with the WTO bylaws. A step in this direction, this paper aims are to review the Saudi Public Works Model Contract vis-a-vis accepted international practices.

The paper is an extension of a larger research project which dealt with evaluating the Saudi Public Works Model Contract vis-a-vis ICE, FIDIC, and AIA. The objectives of this paper are to compare and contrast the Saudi Model Contract versus the UK Public Work Contracts in order to adapt the first one towards international practice. Obviously, the culture of work, country development, jurisdiction, type of administrative and civil courts, and other factors reflected significantly in the design of their public works contracts and public procurement policies. It is interesting to see that Saudi Model Contract use one version for all types of projects leaving each public agency to use its own form of contracts be it lump sum, design build, turnkey and so on. In the UK system, each type of contract in relation to the contract type has been drafted separately to suit the size and type of the project.

Highlighting such shortcomings of the Saudi Public Works Contract should pave the way for re-drafting

it to bring up to accepted international practices, minimize litigation, and improve contract administration efficiency.

Paper 107, Page 866-874

Investigating the Causes of Delays in Occupancy Permit Issuance

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Abstract: The processes of administration and enforcement of building codes and regulations have become very cumbersome. Getting a building or an occupancy permit is complex, time consuming and involves many stakeholders. It mostly leads to unwarranted delays, increased project costs, and needless frustration and aggravation. The methodology and findings of a study conducted in İzmir, with analysis of the causes of delays in occupancy permit issuance and exploration of ways for making the regulatory system more result-oriented, are presented.

The study first sets out a flow diagram showing the regular procedure and the related offices/desks for obtaining occupancy permit from the Housing Department of Konak Municipality in İzmir, Turkey. Then selected projects and their rejection letters are thoroughly examined in terms of their delay times and rejection reasons. An average total delay time of 97 days is recorded for obtaining an occupancy permit. Incomplete document submission required after building supervision in situ is listed as the most frequent rejection and delay reason in the occupancy permit issuance process. Finally, in Konak Municipality in İzmir, interviews are done with all involved parties -the officials of the occupancy permit office of the municipality, the inspectors of the construction inspection firms (CIF) and project owners (or architects). The three parties listed their typical concerns and complaints regarding the occupancy permit process and made recommendations to decrease the total delay time.

Paper 108, Page 875-883

Contract Management: Integration for Best Effect

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Abstract: In this paper the author presents from the perspective of a practicing contracts lawyer some key elements necessary to help construction contract execution. The author considers that the parties' behavior after a contract is entered into is a result of the parties strategic approach to the contract in the first instance. Parties are more likely to execute a contract smoothly if they have a common interest as opposed to similar expectation. Aspects of this thesis are explored and some tips given for smooth contract execution.

Paper 109, Page 884-892

Contract Management Behavior and Practices of Turkish Contractors at International Contracts

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Abstract: Contract management starts with the contract negotiations and lasts until the end of the contract, and is the process that covers three fundamental functions required to compensate the goals of the project; Relationship Management, Project Delivery, and Administration of the contract. This paper briefly discusses contract management behavior of Turkish construction companies in international projects; factors influencing contractors' behaviors, key success factors for contract management, company contract management organizations, claim issues, and conflict and dispute behaviors of firms. Turkish contractors consider contract management to be significant for success at international markets. Contractors are aware of the need for a continuous contract management application although this rate cannot be achieved in practise. Considering awareness as a driving factor for improvement it can be estimated that in future Turkish contractors will be managing their contracts in more efficient, organized and systematic ways than today. Results revealed that; contract management behaviors are

mostly affected by the risk and complexity of the Project, regular contract process is the most impactful process on the success, and change order requests of the owners are the most frequent reasons of claims. According to respondents contract management can reduce number of conflicts and disputes.

Paper 110, Page 893-900

Causes of Delay in Iran Construction Projects

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Abstract: The construction industry in Iran, with an annual turnover of US\$ 38.4 billion, is one of the most profitable sectors in the country. However, the process of construction is very slow and expensive in Iran. Recently, due to a sharp increase in the price of land, materials, equipment and the high rate of population growth, more efforts are being made to avoid delays in construction projects. This paper presents the result of an investigation into the main factors which cause construction delay in Iran. Eleven in-depth interviews are conducted with construction managers and practitioners associated with the Iranian construction industry. Responses are analyzed qualitatively and a comprehensive interpretation is developed. The results reveal that most construction projects in Iran are subject to delay. The negative impacts of delay are explained in this paper. Moreover, the most significant causes of construction delay have been identified. Causes are categorized under three groups of stakeholders, politics and economy. Cash constraints, shortage of resources, high inflation rate, delay in payments, and disputes in supply chain are the top causes of delay in the Iranian construction industry.

Paper 111, Page 901-908

Subcontractor Default Insurance (SDI): A Comparative Analysis with Surety Bonds – the Contractor’s Perspective

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Abstract: Surety bonds have a long history in North American and International construction and many of the current principals of suretyship emanate from Roman law dating back to 150 AD. In 1996, an alternative product for subcontractor bonding was introduced into the United States market – Subcontractor Default Insurance (SDI). Zurich Insurance Company developed the original SDI product (SubGuard®) and remains the only insurer offering this type of coverage. SubGuard® is a two-party agreement between the contractor and the insurer that provides the contractor catastrophic insurance coverage for the cost of subcontractor and supplier default. Unlike surety bonds, SDI is not first dollar coverage, but rather subject to co-pay and policy deductibles. Contractors with SDI programs submit that SDI is a more cost effective approach, with enhanced coverage limits, that gives the contractor greater control in managing subcontractor default. However, SDI requires the contractor to accept additional financial risk, have the capability to prequalify subcontractors enrolled in the program, and accept sole responsibility for the management of subcontractor default. Zurich has indicated that they will soon roll out a SDI program in Europe. This paper evaluates the advantages and disadvantages of SDI and provides a comparative analysis with surety bonding.

Paper 112, Page 909-914

Claim Reduction Strategies in Condominium Construction

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Abstract: Growth in the condo construction market has resulted in a substantial number of claims logged by end users due to lack of performance in the constructed facility. The objective of this study was to identify claim-reduction strategies in condo

construction projects. The focus of the study was on condominium projects that have comparable gross square footage and initial contract cost. All the projects included within the study were executed by large contractors whose annual turnover exceeded 10 million dollars. Results from this study indicated that claims can be substantially reduced in condominium projects through better management and control of waterproofing and interior finish installation. Lessons learned from this study would be particularly beneficial to large general contractors engaged in condominium construction projects.

Paper 113, Page 915-924

Dispute Avoidance and Resolution in Construction Projects: On Paper or in the Minds of People?

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Abstract: Under a construction contract, responsibilities and liabilities of the parties are defined, or should be defined. Within the context of a contract, each party knows or should know his/her roles and duties in order to fulfill the obligations as set out under the contract terms and conditions. In a perfectly drafted contract, errors, omissions or ambiguities in or misinterpretations of the terms and conditions of the contract are minimized, if not entirely eliminated. Based on Author's experience in the construction industry, there has been no such contract that could be deemed to be completely free of errors, omissions and ambiguities or be immune to any misinterpretation. It is therefore almost inevitable that the parties to a contract will end up with disputes. It should also be kept in mind that the contracts are written, signed and administered by the people. Therefore, common sense dictates that the reasons for disputes cannot solely be attributable to the contract terms and conditions not least because there is the human factor involved. This paper first focuses on some major steps that need to be taken in order to help avoid and resolve disputes between employers and contractors in two stages in echelon: the tender stage and the construction stage. The paper then provides a discussion on the subject of human factor as it relates to the ability and willingness of the parties towards achievement of dispute avoidance and resolution.

2.7 International Issues

Paper 114, Page 925-932

Is M&A Strategy Really Helpful for Global Contractors?

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Abstract: As the international construction market becomes more competitive and challenging to global contractors, they cannot cruise alone anymore; they need to collaborate and sail together. To respond to the changing market by shifting toward more competent entities, a number of contractors have performed Mergers and Acquisitions (M&A) which is a typical business strategy to create synergy between two or more different firms. Nevertheless, only few researches have investigated this significant business strategy in the domain of global construction industry. To evaluate the performance of the global contractors who have executed M&A in global construction market, this paper applied Operating Cash Flow Return (OCFR) which is widely used to analyze M&A performance. Moreover, Berry index is used to verify whether the acquirers diversified their products share through M&As. This paper also compares the differences of M&A effects in association with the period of M&A transaction, international or domestic boundary of M&A firms, and aggressiveness in executing M&A. Through an analysis of 190 real M&A cases during the last decade, the authors concluded that the M&A-executed global contractors have overall experienced a moderate level of revenue and cash flow improvement. However, diversification effect of their products portfolio is not unexpectedly well supported in just three years of time span after the execution of M&A.

Paper 115, Page 933-940

Comparison of International Technology Transfer in Construction Projects between Thailand and India

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Abstract: Technology transfer has been defined as the shared responsibility between the source and the destination for ensuring that technology is accepted and at least understood by someone with knowledge

and resources to apply and/or use the technology. Developing and newly developed countries such as Thailand and India stand to gain a great deal from successful of construction industries. This process should provide numerous benefits for both Thailand and India in area such as increased productivity, enhancement of productivity, cost saving, improvement in market share and entry to new markets. However, there are many factors which impact and influence on technology transfer process including the transfer environment, learning environment, transferor characteristic and transferee characteristics. The performance and interaction of these enabler factors influence on the degree of value added to the local construction sectors in areas such as economic advancement, knowledge advancement and project performance. This paper presents the comparison of numerous factors which impact on the international technology transfer process effectiveness between Thailand and India. Though, a main study in Thailand and India, where 145 and 33 industries professional from Thailand and India were respectively interviewed, the factors which impact on the technology transfer process have been identified with factor analysis and the mean and standard deviation value for factors and sub-factors are computed to compare the rating of TT factors and sub-factors between Thailand and India.

Paper 116, Page 941-949

Determinants of Glocal Success in International Construction

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Abstract: Globalization is triggering construction companies to act in multinational markets. Although, it is a major resource for the growth of companies, understanding the factors (opportunities, threats) that influence international construction is also compulsory for the successful accomplishment of projects. Besides, in order to focus solely on the core business, companies should have the capability to manage those factors by eliminating the threats of the factors such as strategic fit, cultural fit, host country conditions (e.g. political, macro economic, legal system) which are not project related but differ depending on the partner and the host country, in which the project is executed. Herein a compromise is proposed to be the term “glocal” as a concurrent

combination of the international business activities (global experience) with local adaptations (local know how). “Glocal” is a new definition of a known concept for the strategic aliening of an international company with a local partner. In this research; definition, benefits, risks, problems and probable determinants of success in glocalization was investigated by an in-depth literature review as well as having the experiences of the practitioners.

Paper 117, Page 950-958

A Review of Growth for Construction Service Companies in Global Markets

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Abstract: Throughout the developed world, professional services play an increasingly important part in an economy, with many countries showing a substantial positive trade balance for services. Yet, there has been relatively little research on construction services (CS) and, in particular, how well professional service companies (PSFs) perform in the international arena. The method for collecting services export information differs to the way in which goods and products exports data are gathered because of the intangible nature of services.

Organisational growth of companies aims to share risks across different regions and sectors, however, the rapidly changing business environment challenges companies with the increasing foreign ownership and changes in procurement. The complexity of today’s international construction services organisations raises two questions: how the organisations can successfully manage growth and what are their motives for international trade.

The research focuses on top UK consulting engineering companies to understand their organisational strategy, their export strategy, and drivers for overseas activities. The data will feed a model of professional services exports, which can help to inform the way services export data could be collected to better reflect the industry’s performance.

Paper 118, Page 959-966

Construction Skills Shortages – Any Global Lessons Gleaned from UK Scarcity?

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Abstract: Despite recent credit crunch developments and their potential detrimental impact on levels of construction activity, the United Kingdom (UK) construction sector is still perceived as relatively buoyant appertaining to construction output levels and employment prospects. Numerous construction industry experts have commented on the prospect of the UK construction sector overheating, a situation exacerbated by the deliverance of, amongst other high profile projects, the 2012 London Olympic Games. The UK Government's Department for Trade and Industry (DTI), responsible for all aspects of the UK in terms of business and commerce, has identified a construction skills crisis as one of its main areas to focus on.

This paper will review existing literature to ascertain why people are not choosing to enter the construction industry, identify problems which arise from a shortage in skilled labor, discussing and establishing why it is not a popular choice of career and finally providing recommendations as to how the current labor shortage can be addressed. The paper ultimately proposes possible solutions to labor shortages which, in due course, could be adopted by other countries when faced with similar circumstances.

Paper 119, Page 967-974

Weathering the Storm: The Impact of the Global Economic Crisis on the Construction Sector

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Abstract: Since the end of 2008, countries in both the developed and developing world have begun to feel the effects of the current global 'credit crunch'. Whilst the epicentre of the financial crisis has been the U.S.A., the U.K. and the rest of Europe have also experienced a rapid decline in the level of confidence in the financial sector and the consequent slowdown in the economy with its devastating effects on the demand for construction activity. The fact that the housing market was at the root of the initial financial problem had a major impact on the construction industry and, because a major issue in the recovery packages is infrastructure stimulus spending, the construction sector is at the heart of both the initial economic decline and the recovery. By reference mainly to the U.K. (but also the wider international) experience, the basic causes of the economic crisis can be explained, the effects on the construction sector considered, and the alternative approaches to solving the problems can be examined.

Paper 120, Page 975-983

A Critical Review of Ethics Issues and Corrupt Practices in the Global Construction Industry

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Abstract: Unethical conduct and corrupt practices in engineering and construction enterprises worldwide create adverse humanitarian impacts and significant economic costs. Related issues have been addressed by a number of agencies in the U.S. and abroad, and several collaborative initiatives have been undertaken in recent years to identify and correct the existing deficiencies, which has led to changes in the American Society of Civil Engineers' (ASCE) ethics code and the development of various mechanisms to combat corruption in the global construction industry. The information available from ASCE, Construction Management Association of America (CMAA), Fails Management Institute (FMI), Transparency International (TI), World Bank, World Economic Forum (WEF) and other sources is critically reviewed in this paper with reference to bribery, fraud, extortion, collusion, money laundering, bid shopping, change order, and payment and claim games. The roles of government, industry organizations, ethics codes, corporate ethics

policies, ethics education and training, and new legislation are reviewed as the building blocks of improving the ethical environment.

2.8 Knowledge Management

Paper 121, Page 984-991

Impacts of Cultural Differences on Knowledge Management Practices in Construction

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Abstract: Knowledge management in the construction industry is essential for improving the business performance. Effective knowledge management can reduce project time and cost, improve quality and provide a major source of competitive advantage for the construction organizations. On the other hand, knowledge management practices can be affected by cultural differences since culture has the potential to impact on business activities. This paper presents a part of the research that was conducted among eleven UK senior managers who have some years' of experience in international projects and are involved in UK construction business. In this study, one of the specific objectives was to find out the opinions of managers about the possible effects of cultural differences on management practices in construction. Within this context, semi-structured interviews are carried out among these managers. The interviews took place over a 3-month period between November 2007 and January 2008, and each lasted approximately 1 hour. Analysis of the qualitative data has been carried out using NVivo 2.0 software. The analysis of the interviews showed that cultural differences have an impact on knowledge management practices in construction but in different ways and levels.

Paper 122, Page 992-999

Exploring the Use of Semantic Web Techniques for Representing Knowledge about Sustainable Building Technologies

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Abstract: The global quest for sustainability in the exploitation of resources and the need for carbon foot-print reduction are generating a large number of innovations and a huge amount of knowledge on sustainable building technologies. Unfortunately, users are being overwhelmed with information overload in this area and it is difficult for them to make informed choices. The emergence of semantic Web technologies, the next generation of Web technologies, promises to considerably improve information representation, sharing and re-use to support decision making. The aim of the work presented in this paper is to explore the extent to which emerging semantic Web technologies can be exploited to both represent information and knowledge about sustainable building technologies and to facilitate system decision making in recommending appropriate choices for use in different situations. This paper presents an overview of emerging semantic Web technologies and emerging innovations in sustainable building technologies. A conceptual model for representing this information is presented. The use of this model to develop a prototypical ontology for representing sustainable building technology knowledge in the Photovoltaic system domain is discussed. The outcomes of the exploratory work that has been undertaken to identify and use various tools for the representation of knowledge and making inferences from the knowledge are discussed.

Paper 123, Page 1000-1009

A New Generation of Demo-Projects for Sustainable Sector-Integrated Innovations

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Abstract: The building sector is currently pressured by a global call to review its management of the flows of matter and energy. A radical change is

required and at the same time a change is going on. Design processes and construction management are actually inserted in a changed new operational context deeply influenced by the sustainability and globalization debate. The focus has been moved to energy and matter flows as the peculiar base of all building business and this fact introduces ecology as a base knowledge in construction. Ecology is the science of intelligent, self-organizing complex systems.

Large complex systems react to change and innovations are the tools the system creates in order to adapt. The management of innovations in construction has been a complex, theoretically weak and often ill-defined problem partly due to the contingency and heterogeneity of all parts and variables involved. This study highlights the emerging of new practices able to link knowledge innovations and project managing processes when sustainability goals are on stake.

Demonstration projects are the investigated unit assumed as contexts for the co-evolution of research, design and management developing technological change and innovations. The discussion is based on real case-projects studied within a stakeholder participatory approach. Findings reinforce the need of identifying and better understand integrated sector-specific innovations. Still innovations in construction can be inconsistent with concepts of sustainability.

Paper 124, Page 1010-1018

Fuzzy Logic Model for Benchmarking Knowledge Management Performance of AEC Firms

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Abstract: Knowledge management is rapidly becoming a key capability for creating competitive advantage in the construction industry. The emergence of knowledge management as a key capability for creating competitive advantage poses enormous challenges to executives of construction firms. This paper proposes a model for benchmarking knowledge management performance of AEC firms that can guide construction business executives to meet these challenges. The proposed model incorporates benchmarking and knowledge management concepts with fuzzy set theory to adequately handle imprecision, vagueness and

uncertainty that prevail in this process. It uses the fuzzy-weighted average (FWA) algorithm to benchmark the knowledge management performance of AEC firms. It is an internal reporting model that can guide executives of AEC firms to benchmark and evaluate their firm's ability to achieve their strategic objectives and to pinpoint their firm's strengths and weaknesses in order to neutralize threats and to exploit opportunities presented by today's construction business environment. A real-world case study is presented to illustrate the implementation and utility of the proposed model.

Paper 125, Page 1019-1026

Spiral of Knowledge, Network Theory and Communities of Practice in a Consulting Engineering Firm

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Abstract: There has been a great interest in knowledge management theories within the construction sector to achieve competitive advantage. A case study was conducted in a consulting engineering firm to evaluate the application of various knowledge management theories and practices. A spiral of knowledge was identified amongst the firm's engineers while network theory explained the codification and sharing of knowledge among the practicing engineers. The firm further adopted the concept of communities of practice to strengthen its internal networks and harness knowledge sharing and management.

Paper 126, Page 1027-1034

Examination of the Relationships among Leadership Styles, Organizational Culture and Knowledge Management Practices

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Abstract: Recently, the relationships between leadership behaviors and knowledge management have been the focus of much attention and as such have become a 'foundation stone' of endeavors to improve organizational performance. However, there is the lack of attention to the impact of organizational culture on such relationships. Addressing this research gap, this paper utilizes an exploratory research designed to examine how leadership behavior relates to knowledge management practices, and to determine whether organizational culture moderates the relationship between leadership style and knowledge management in Australian small-to-medium sized enterprises (SMEs). Surveys were distributed to 1,000 SMEs, and a total of 157 valid responses were received. Statistical analysis reveals that only transformational leadership behaviors are positively related to knowledge management practices; and the moderating effect of organizational culture was found to be statistically insignificant.

2.9 Facilities Management and Maintenance

Paper 127, Page 1035-1042

Correlation Analysis of Building Performance and Occupant's Satisfaction via Post Occupancy Evaluation for Malaysia's Public Buildings

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Abstract: The purpose of a building is to provide shelter for activities that carried out by the building users. The question is, does the facilities in the building perform well and appropriate to its use? The needs of occupants are affected by the building performance and on occupants' evaluation of the buildings. Hence, Post Occupancy Evaluation (POE) is introduced to empower the occupants' opinion as the benchmark of building performance evaluation. POE comprises as one of the technique that is used to evaluate whether a building meets the user's requirement. The broad aim of this paper is to determine the correlation of public buildings and

occupant's satisfaction; in order to seek possible opportunities for government involvement (as the building owner) and the public (as the user) to evaluate the performance criteria. By using a proposed framework of POE, the study has revealed that 74% of the aspects in building performance are in high correlation with the occupants' satisfaction. The study concludes that the application of POE is effective and beneficial to be used by the public sector in evaluating the performance of public buildings in Malaysia.

Paper 128, Page 1043-1050

Maintenance Approaches of Historical Buildings in Malaysia

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Abstract: The conservation of historic buildings is an established method to preserve a heritage structure through restoration and maintenance works. Maintenance has been identified as a key intervention in protecting historic structure by prolonging the lifespan of building. The importance of carrying out a systematic and routine maintenance works as part of the conservation programme is often neglected due to a misunderstanding on the needs of the works subsequent to the conservation works carried out. Note that without a systematic and proper maintenance approach, historic buildings will deteriorate and will not be able to function as it is. This paper intends to highlight the current practice of maintenance approaches that are being implemented in historic buildings in Kuala Lumpur. As the capital city of Malaysia, Kuala Lumpur has a vast number of unique historic buildings. Each building has its own unique character and significance, be it cultural, historical or architectural. The findings for this research are summarized from the responses obtained directly from the respondents employed for the maintenance management of the historical buildings. Twenty historical buildings (of which some are already categorized under national heritage) were involved in case studies that were carried out. The methodology used for this research is through personal interviews and distribution of self-developed questionnaires focusing on the current approach taken for the implementation of maintenance works on these buildings. The outcome of this paper will be used as a basis for the formation of the best maintenance programme for historical buildings in Malaysia.

Outsourcing of Hospital Support Service in Malaysia: A Survey Results

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Abstract: In Malaysia, over the last decade, outsourcing has become one of the major issues in health care. Two major concerns are related to the practice. The first one involves the suitability of the outsourcing strategy, principally with reference to the outsourcing of hospital support service. The second one relates to the actual benefits of the outsourcing practice in terms of cost reduction and increasing efficiency.

In order to achieve the research objective, a questionnaire was developed and, after a pilot test. It was mailed to public hospital development unit, service providers and consultant. The data gathered concerning their experience and knowledge and the response rate was around 39%. The survey results clearly demonstrate that to do the project successfully, a number of stages need to be considered in outsourcing strategies and process. These result also indicated that the outsourcing projects of public hospital in Malaysia are expand and increasingly in used. It is improving the service and getting more efficient to the service. Very few of the respondents agree on the inefficient and unsuccessful of the outsourcing public hospital support service project in Malaysia.

A Review of the Data Collection and Management Technologies for the Operational Stage of Facilities

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Abstract: Buildings are considered to have an ongoing life if thought together with the human-beings living/ working in. Buildings pass through several maintenance and operation activities during the life cycle of any facility. Several types of

information technology tools are used in the operational stage of facilities. For example, the activities are directed by facilities managers and the results are registered with Computer Aided Facilities Management (CAFM) programs. CAFM programs store data in specialized file formats or databases. However, in order to use and manage all kinds of data that appear through the life cycle of a building project, the concept of Building Information Models (BIM) which depends on intelligent object has begun to be used. Therefore, it has become possible to share all kind of building related data from shared building models.

Embedded technologies are another technology to facilitate the building management process. With these technologies it has become possible to collect real-time data from the operation field and to record the maintenance - operation data of several service equipments. These data are written to the intelligent chips locally and sometimes a remote database is populated. If Building Information Models could be populated with the real time maintenance data captured by embedded systems it would be possible to attain an architectural component based (e.g. space, room, etc.) operations and performance monitoring platform.

This research project explains the initial thoughts on integrating various technologic tools that are used in the operational stage of buildings. Field data collection and management techniques e.g. Computer Aided Facilities Management (CAFM), Building Information Models (BIM) and Radio Frequency Identification (RFID) are reviewed and advantages / disadvantages of each system has been given shortly. Later, initial guidelines for a proposed IT system have been given in order to improve the presented drawbacks. Data, collected via embedded systems will be integrated with Building Information Models which would lead to an operation / maintenance platform. This platform will be used to monitor the performance of building services and building components.

Paper 131, Page 1066-1071

Variability in the Application of Space Management Tools for Facilities Managers

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Abstract: Facilities Management is increasingly developing as a profession with space management as its core activity and opportunity to add considerable value to clients. Space management has seen many changes over the last few decades due to the development of Information and Telecommunications Technologies and Automation (ICT&A). These technologies such as the internet and mobile phones has resulted in people moving out of the traditional office and being able to work anywhere, anytime. A wide range of organisations have embraced the opportunities opened up by telecommunications and has given the option to employees who can work ‘smart’ or ‘flexible’.

Current methods of gathering information for space management involve observers recording use of space or activities that engage staff. Records are made manually, in a fashion similar to old ‘time and motion’ studies. It is evident that Facility Management decisions on space take time as all information and assessment are carried out manually. It is argued that the continued use of informal evaluation techniques is likely to exacerbate the disparity between actual and expected performance of spaces.

2.10 Education and Training

Paper 132, Page 1072-1079

e-learning Materials for Quantity Surveying Measurement

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Abstract: Quantity surveying measurement (or taking-off) adopts prescriptive processes which are underpinned by understanding construction technology. The rules for measuring are complex, and are designed for experienced practitioners. Some students find it difficult to acquire the mix of skills and knowledge within the timeframe allowed. At the University of Newcastle (Australia) we use high quality teaching and learning materials for both on-campus and on-line distance learning students. The e-learning measurement packages (which incorporate 3D images) have been developed in collaboration with the Department of Civil and Building Engineering at Loughborough University (UK). This paper describes and discusses some of the merits and challenges of the approaches we have adopted as well as the assessment processes we use.

Paper 133, Page 1080-1088

How to Jumpstart a University of Botswana Project Management Group

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Abstract: The success of the Performance Based Studies Research Group (PBSRG) at Arizona State University has been well documented. It used a new model of simultaneous research of basic theory, prototype testing, and implementation of research based systems. It used an alignment of graduate education, and created an industry interface that participated heavily in the research testing. The technology developed by PBSRG was based on best value practices, deductive logic, and simplicity, instead of best business practices. The performance measurements of the research tests were dominantly better than the status quo. PBSRG has tried to unsuccessfully move the research platform and the research to other universities. The authors hypothesize that a complete strategic plan must be aligned with the faculty, the industry need, and the university direction of high impact research, publications, and value added education. A change in organizational structure to a more informal group, with liaisons for funding purposes may be needed until the effort can be officially absorbed by an official academic unit. The test is at the University of Botswana (UB) project management section, in the Civil Engineering Department, in the College of Engineering.

Paper 134, Page 1089-1097

Graduate Risk Management Research and Education Program in Botswana

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Abstract: Many graduate programs in risk management are embellishments of undergraduate risk management education, with the discussion of more potential solutions, more technical details and additional assignments analyzing the status of risk management. The authors propose that the paradigm for risk management education should be first to improve the existing risk management process model, and second, the theoretical dismantling of existing paradigms and discussion, through the use of theory validation by testing, measurement and the use of case studies, thus

minimizing personal experience and bias. Graduate education should sharpen the graduate students' personal risk management capability by enhancing their individual perceptions and by practicing risk management, learning that risk management is a technique that applies to all types of projects regardless of technical area. A current research test is ongoing to transition from an education based risk management class to a research based class at the University of Botswana. The authors document the existing syllabus and requirements, and the new syllabus, the changes, and the methodology of the new class.

Paper 135, Page 1098-1103

Training Needs in the Local Infrastructure Construction Industry Market in North Cyprus

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Abstract: The North Cyprus economy experienced a construction boom in the aftermath of the UN Peace Plan known as the Annan Plan for settling the Cyprus problem. However there has been little attention given to the 'know-how' of the construction companies' and how to face such a boom. The structure of the construction companies on the northern part of the island is relatively small and family owned where traditional and short-term approach is common. Furthermore, these local companies are losing their competitive edge to international companies at larger scale projects which are internationally funded. Within the last year, two infrastructure construction projects were observed to identify the shortcomings of the infrastructure construction industry both at the management and technical skills level. Findings show that project management and the technical staff's know-how is limited. Furthermore, the management does not have the appropriate background leading to series of problems at every level of a project cycle. The future of the local construction companies in Northern Cyprus is ambiguous if the attitude towards improving their know-how and training their staff to meet the demands of the industry does not change. Structured training that will incorporate the needs of the local companies and the technical staff might sustain the local construction companies' existence in the long term.

Paper 136, Page 1104-1112

Teaching Globalization Issues to Civil Engineering Students – The International Collaborative Construction Management Course

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Abstract: Several construction companies have reported that their engineers and project managers are not prepared to deal with the requirements of the increasing globalization that is creating new opportunities with expanding markets all over the world. Construction companies, engineers, and project managers are realizing that their domain knowledge on materials, equipments, construction techniques, management techniques and methods, and social skills are local. Traditional construction management education does not prepare engineers for these challenges. This paper introduces and presents the lessons learned of a course titled “International Collaborative Construction Management” that has been developed and taught to fill this gap. The course exposes students to an international collaboration experience. Students in the US, Turkey, Brazil, and Israel are teamed with students from the other countries, and the teams are expected to present schedules, estimates, risk assessment plans, and process models of a facility to be built in one of the participating countries. Students learn not only how to develop construction estimates and schedules, but also, globalization issues, methods for working on multicultural teams, negotiation techniques, and methods to improve international collaboration enhanced by the use of information technology.

Paper 137, Page 1113-1121

Delivering Integrated Engineering and Architectural Design Education

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Abstract: The relationship between the engineer and the architect remains the most significant association in the architectural design process and realisation of the built form.

In architectural education, the architectural design task is set to establish certain specific learning outcomes. However, the overall aspiration remains to establish holistic design capability. The writers have prepared and delivered an integrated educational programme that encourages the development of holistic thinking, across specifically the class subject areas of Building Technology and the Architectural Design Studio, within the BSc in Architectural Studies (Hons.) degree and within the multi-disciplinary projects undertaken by students studying for the Building Design Engineering (Hons) degree.

An integrated curriculum is fraught with issues of delivery and content. It must also be tested against contemporaneous issues which can impact negatively on this aspiration and can cause the disintegration of holistic design capabilities. For instance, continuous advances in Computer Aided Design representation skills allow the student to present to a very high degree of sophistication which can sometimes mask their minimal understanding of basic structural or construction processes. Other contemporaneous issues however such as sustainable design do present an opportunity to re-invigorate the relationship between the disciplines.

The writers maintain that the two professions, engineering and architecture, need to persist in identifying shared common ground in times of technological and environmental change. The paper proposes to present case studies as evidence of the writers’ attempts to improve the mutual understanding and respect between the engineer and architect.

Paper 138, Page 1122-1130

Qualitative Research Methods in Project Management Research in the Built Environment

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Abstract: It is now commonly accepted that qualitative research methods have an important role to play in project management research in the built environment sector. This acceptance emanates mainly from the realisation that projects and project environments are highly complex and context dependent; and therefore qualitative research is better suited for their exploration. Even so, there is a gap in the literature with respect to the execution of such methods in research projects and their appropriateness. This paper aims to make a contribution to closing this gap by evaluating the use of cognitive mapping and social network analysis (SNA) techniques in two research projects conducted on the UK construction industry. The first section reviews the recent debates on qualitative research paradigm in project management research in the built environment sector and concludes with the identification of the gap in the literature. The second section adopts a case study approach and conducts a SWOT analysis on the use of cognitive mapping and SNA in two UK research projects. The fundamental aim of this analysis is to determine the appropriateness and performance of these methods in the given contexts. A discussion on what qualitative research methods have to offer to the project management research community in the built environment sector concludes this paper.

Paper 139, Page 1131-1136

A/E/C Integration: An Education and Training Program

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Abstract: Globalization, increasing project complexity, and emerging technologies are among the major drivers affecting the Architecture, Engineering and Construction (A/E/C) industry. These changes are overtaking the A/E/C industry and are forcing formally fragmented groups to work

together to create a more efficient, economic and sustainable product. The organizations that will move ahead in this climate understand and embrace these changes. More importantly, they are led by individuals who possess the skills and foresight needed to successfully meet these challenges and incorporate change. The goal of this paper is to present a summary of discussions and ideas generated from a workshop at the Georgia Institute of Technology on how to prepare an integrated education program in two core areas: (1) cultural and organizational changes affecting the industry; and (2) the industry's current and future technological needs. Cultural change refers to establishing a mindset based on teamwork, collaboration, and empathy for the differing roles and responsibilities of various stakeholders involved in the industry. Technology need refers to the specific IT tools used in the A/E/C industry, such as Building Information Modeling (BIM). It also includes training in delivery systems, process management, telecommunications, shared work environments, and other innovations.

Paper 140, Page 1137-1144

Captured Construction: A Digital Media Library of Building a Construction School

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Abstract: Building construction involves multiple disciplines carrying out many varied activities. Modern information technology, especially digital multimedia and the Internet, allows construction processes and activities to be easily captured and publicized. During a two-year period, three thousand digital photographs and many hours of digital videos were captured to document the construction and management activities throughout the building process of a new state-of-the-art facility for a construction school in the United States. Faculty members in this ACCE accredited construction management degree program have developed an online digital library using these captured media to enhance teaching and learning about construction. The library helps students and educators access relevant construction knowledge about the building they occupy. With a digital collection management software program called CONTENTdm™, media in this library are selected, enhanced, cataloged and made searchable online. Finding media in the library is facilitated using keywords chosen from the common vocabulary of construction educators,

students, and practitioners. Examples are materials: concrete and rebar, labor: carpenter and mason, equipment: backhoe and crane, tools: hammer and total station. This paper explains the implementation of this digital media library and introduces examples of its application as a relevant visual resource for teaching and learning about construction. Feedback from students and faculty for using and improving this library is also discussed in this paper.

Paper 141, Page 1145-1151

Recent Issues in Civil Engineering Education

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Abstract: The year 2008 has seen the publication of the second version of the report of the Body of Knowledge (BOK) Committee of American Society of Civil Engineering (ASCE). The report gives the opinion of eminent engineers and academicians on what, how and by whom will be taught to 21st century's civil engineers. Starting from the 11 criteria of ABET, putting down measures for evaluating universities as to their outcomes, the BOK Committee ended with 24 criteria grouped under three major titles: Fundamentals, Technics and Professional Issues. Among these titles, the one that has seen the maximum attention is the third one, aiming to obtain civil engineers more open to social life. Another important issue in the work of the committee is the degree up to which these abilities will be given to candidates of civil engineering.

3. Information Technology and Information Systems in Construction

3.1 Information Technology

Paper 142, Page 1152-1158

An Automated Entities Extraction Model for Elements Recognition from the Structural 2D Drawing

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Abstract: The players in construction industry are still relying on manual extraction from the drawing for the element's details for quantity estimating, planning and scheduling, and other related activities. Unlike industrialized construction, the conventional construction is under increased pressure to measure the quantities and under tight schedules exercise automation for a better project management. Since the design serves as a source for all construction processes, the building information modeling with the specifications and the details based on elements provides the possibility of accessing the required details from the drawing directly. Conversely, the 2D drawing is complex enough to automatically recognize and identify the elements, their shape, and the properties like length, height etc from the primitive drawing shapes such as lines, arcs and texts. However the development of fuzzy logic's rule based algorithm recognizes the elements through its properties. This paper presents the conceptual model which has been developed through extracting and recognizing the element's details from the structural 2D digital drawing effectively.

Paper 143, Page 1159-1166

Automated Planning of Collision-Free Paths for Material Handling Equipment

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Abstract: Determining paths for transporting materials at a construction site is an important planning activity. Typically, construction of building facilities entails various activities involving transporting, storing, preparing, and placing building materials at different locations within the boundary of a site. It is necessary that materials be transported to storage locations and become readily available and accessible when they are needed. Discrete-event simulation tools exist for modeling and visualizing movement of pieces of equipment and materials and identifying related spatial conflicts. The simulation tools allow engineers to conduct what-if analysis and to assess the effectiveness of material-handling operations. However, such simulation tools do not necessarily provide a solution that result in conflict-free operation. This paper presents a research approach that focuses on determining conflict-free paths for material transportation. The approach takes building design and schedule information to create a configuration time-space representation of a site and utilizes a path planning algorithm to construct a roadmap, which is a connected collision-free path for transporting materials at a construction site. At last, the paper concludes with possible applications of the generated roadmap and ongoing research works.

Paper 144, Page 1167-1175

Managing Information Technology in Construction: Case of the Turkish Construction Industry

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Abstract: Effective IT implementation in construction is necessary to improve productivity; however the uptake of IT applications has been limited. This paper explains the results of a research that aimed to investigate the current state of IT in the Turkish construction industry. For this purpose, a questionnaire survey of 84 contractors was conducted. The survey includes the use of software, hardware, expertise, and benefits gained and problems associated with its implementation. It is encouraging to see that most of the respondents reported that they exploited IT in their business processes, which mainly include; accounting, design/drawing, tender preparation and bidding, costing/budgeting, technical calculations /engineering analysis, material purchasing, general administration, and project management. The survey results revealed that the use of IT raises the

following benefits for companies; ease of monitoring the progress of the ongoing projects, ease of capture of meaningful information, enhanced competitive advantage of the company, faster delivery of services, and ease of document tracking and management. Despite these advantages, there are some barriers to the extensive use of IT, which include; lack of trained personnel, lack of knowledge, rapid changes in technology, unawareness about the capabilities of the available technologies, and lack of top management support. The paper suggests that all the relevant parties should do their part in order to increase strategic use and adoption of IT in the construction industry.

Paper 145, Page 1176-1181

Digital Technologies in Built Environment – An Overview

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Abstract: Digital technologies are influencing the way we live. It is also shaping the way we design, construct, and manage the built environment around us. From collaborating design and construction ideas to creating the actual design to communicating on-site to training construction workers on health and safety issues there are different levels of involvement of the information and telecommunication technologies in the construction industry. Use of these diverse digital technologies is also spread through to the manufacturing building materials, public planning, and inspection process. The aim of the study is to offer a structured overview, which encapsulates these digital technologies that are being used and can be used in the AEC and property professionals. This study will also explore how these technologies can be introduced to the future professionals who will be the part of this digital practice. The study considers the need for a seamless approach to integrate digital technologies in built environment education and industry where blend of theoretical understanding of the subject matter and technical competence is required.

Paper 146, Page 1182-1189

A Study of Turkish Construction Consultancies for the Applicability of Project Extranets

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Abstract: A group of construction consultancy services in Turkey were investigated for their existing information and communication technology policies and their attitude towards web-based project management systems (project extranets). Turkish construction sector has become very competent in overseas jobs during the last decade. There are many design offices in Turkey providing services for overseas construction jobs. One would expect them to utilize project extranets more extensively due to distance between the construction sites and consultancy offices. However, while a significant portion of Western construction consultancies have been enjoying project extranets, the most of the Turkish consultancy businesses are still using only email, instant messaging, and mobile phones for their communication needs. While the internet connectivity and extended use of computer aided design technologies have proliferated in consultancy services in Turkish construction industry, there is very little interest towards project extranets. The research work gives a short portrayal of Turkish construction sector, covers a concise literature review on project extranets, and exhibits a small empirical study of 5 Turkish construction consultancy businesses. The study investigates the existing capabilities and attitudes towards information management, both at employee and management levels. Several semi-structured interviews at each company were conducted. The results are mixed, with a scale ranging from a total rejection of the idea to a claim to have similar systems already in place.

Paper 147, Page 1190-1198

Elevating Construction Equipment Fleet Management To a New Level: An Evaluation of Use of Telematics Technology

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Abstract: Construction industry has not kept up pace in the adoption and use of new technologies in general and for fleet management of construction equipment in particular. As a result, the efficiency, productivity and profitability in relation to construction equipment use has suffered. Fleet management in the U.S.A, to some extent, still relies on traditional and labor intensive methods of data gathering and evaluation, thus depriving the management from acting on current and reliable data in a timely manner.

Use of the “telematics” technology has the capability to enhance constructions equipment-fleet management to a whole new level. This paper focuses on a recent collaborative research undertaking to find more about the details of this technology and its impact so far on equipment-fleet management. The purpose of the research was to evaluate the use of this technology in construction companies, determine its user acceptance, and assess the differences it was making in fleet management. The difference was to be assessed in terms of how this new technology had changed spatial equipment tracking, equipment utilization, equipment maintenance scheduling, operations analysis, job costing, and jobsite/project management related to construction equipment. Presented herein are the details of the technology, the methodology of the research undertaking, the results of the evaluation, and the conclusions thereof, for the purpose of disseminating such information for the benefit of the construction management educators and the construction industry.

Paper 148, Page 1199-1208

A Comparison of Tabu Search, Simulated Annealing and Genetic Algorithms for Discrete Time-Cost-Quality Trade-Off Analysis

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Abstract: The discrete time-cost-quality trade-off analysis is a classical Multi-Objective-Combinatorial Optimization (MOCO) problem. Construction management researchers have been using combinatorial optimization algorithms to solve this multi-objective optimization problem. These algorithms are both approximate and blind. These features of combinatorial optimization algorithms have raised a number of questions on their relative performance and triggered a number of research studies. The research presented in this paper compares the relative performance of three popular combinatorial optimization techniques, namely Simulated Annealing (SA), Genetic Algorithm (GA), and Tabu Search (TS), on a test problem with respect to three performance criteria: (1) quality of optimal solution, (2) computational time and (3) number of candidate solutions evaluated before reaching the optimal solution. The test results suggest that TS, GA and SA perform well in finding the optimal solution. TS outperforms both SA and GA in terms of computational time and number of candidate solutions evaluated before reaching the optimal solution for the test problem.

3.2 Information Systems

Paper 149, Page 1209-1217

Management Information System: An Innovative Tool to Monitor and Control of All Corporate Processes Related With the Construction of the New Railway in Greece

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Abstract: The Ergose's Management Information System (MIS) objective is to assist the decision support functions in almost all corporate processes related with the implementation of the new railway construction in Greece. The MIS main scope is to organize, standardize, control and monitor the

majority of the corporate central processes such as programming, design, land acquisitions, tendering, construction, procurement and quality control. The system was implemented through several project phases with a common methodology, the definition of the scope and the project team, gap analysis, system design, functional requirements, software development, acceptance test, user training, system operation and the evaluation of results. The core of the MIS is based on a database management system, an application development framework, an internet site for online reporting and multidimensional statistical analysis and a Document Management System. The operation of the system resulted in the improvement of the data quality and flow, the reduction of the time and manpower needed for monitoring and controlling several corporate processes, the assistance in the decision support and risk management processes and the improvement in the collaboration with third parties. The key benefit of the system is the significant improvement of the corporate project management effectiveness, efficiency and maturity.

Paper 150, Page 1218-1226

Landslide Definition by an Integrated Monitoring System

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Abstract: Landslides are one of the major types of natural hazards being responsible for great infrastructure damage world-wide, endangering thousands of people every year. In this paper, the case study of a big embankment of Egnatia Odos Highway in Northern Greece, founded on a landslide area, is examined by the means of an Integrated Monitoring System. The major goal is to define the exact area of the landslide, describe the characteristics of the movement (displacement/deformation) and determine the environmental causes that contribute to the phenomenon. The system consists of a combination

of geotechnical instruments and a geodetic high precision monitoring system. The geotechnical instruments consist of deep inclinometers, piezometers and tiltmeters, which provide data of the sub-surface displacements and surface tilt deformations along with piezometric data.

The high precision geodetic monitoring system, based on GPS and high precision motorized TPS measurements, provides surface displacements, which combined with the inclinometer data, makes it possible to determine the geometry and kinematics of the unstable area.

The deformation history results are examined in combination with geological and environmental data provided by piezometers, standpipes and rain-gauges to assess the stability condition and design the most adequate compensation measures.

Paper 151, Page 1227-1234

A Computer Model for Selecting Equipment in Earth-Fill Dam Projects

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Abstract: Optimum selection of the right equipment plays an important role in the success of any construction project. This paper presents a computer model, ESCMODEL, for selecting equipment fleet in earth-fill dam projects. The model is capable of assisting the users in making decisions to determine the size, number, type and schedule of dozers, loaders, graders, excavators, trucks, sheepsfoot rollers and smooth wheel rollers. This model contributes to the selection process through the application of an optimization technique, based on nonlinear programming. The paper concludes with a proposal to concentrate on the development of a computer model to identify the number of equipments to be bought or rented. One actual case study are presented in order to illustrate the effectiveness and performance of the model.

Paper 152, Page 1235-1241

Information-Oriented Integrated Design Management System

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Abstract: A construction design project follows a complex process of designing corporeal buildings from incorporeal information. With construction projects becoming bigger, there are now more participants in a single project. This makes the communication and information flow among the project participants a key success factor of the project. Moreover, unsystematic and qualitative design management has made it difficult to accurately manage design work. This reality has been detrimental to the development of the design industry. For effective design management, a computerized design management system that controls design information and its flow is needed. This design management system must guarantee a uniform quality of design outcomes, regardless of personal experiences.

This research is based on the concept that if an integrated design management system can reduce the management efforts of designers, design quality can be improved. An information-oriented integrated design management system is hereby proposed. The following three design management system applications are presented: design documents management, design personnel management, and design progress management. A design documents management application was developed based on the design work process, and a methodology that can be applied to design progress management was developed using design work and design products. Also, using the information accumulated during the design process, the resources that must be inputted into design work were analyzed. All these three design management tools are not separate from each other but are connected to each other so that one input datum can be used for two different aspects and will result in different managerial outcomes.

Paper 153, Page 1242-1248

Development of the 3D Computer System to Automatically Quantify Construction and Demolition Waste

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Abstract: The current trend of pursuing sustainable development in the demolition industry reflects the importance of reusing and recycling construction and demolition (C&D) wastes. Considering the situation of housing construction and existing houses in Korea, the demolition market is expected to be continually increased. Thus, for keeping up with this demand, it is necessary to be able to accurately forecast and manage C&D waste generated at the demolition phase. But because most of demolition companies are small in size and investment in technology development is insufficient, it is difficult to establish standards and develop an integrated system of appropriately managing C&D waste. Therefore, this study aims to develop a 3D system to automate estimating a quantity of demolition waste. This system will make it possible to integrate and manage in one system such activities related to demolition work as planning and scheduling of demolition work, and quantifying and planning for the disposal of demolition waste. Also, this 3D visualizing system can automatically quantify demolition waste by using a 3D object library, and manage schedule of demolition work by visualizing 4D CAD.

Paper 154, Page 1249-1256

On the Genetic Algorithm Optimization of Non-Geometric Brace Systems

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Abstract: One of the desirable brace systems in seismic areas can be presented as non-geometric brace system, which has the advantage of architectural transparency. This system consists of three members. The non-straight diagonal members (which introduce eccentricity to the brace system) are connected to the corner of the frame by a third member. The connection's location on these three-brace elements has a significant role on the stiffness of this system. Although designer can compute the stiffness of the frame based on structural analysis principals, but finding the best connection's location offering the highest stiffness value in the panel area with various parameters is indeed intricate. In this paper, eccentricity optimization to obtain the connection point which has the highest stiffness is carried out based on genetic algorithm. In addition, the effect of using elite individual, selection rate, number of mutation and crossover on the number on generation and iteration are investigated. This study highlights that the utilization of elite individual has significant effect on decreasing the number of generation for optimizing the eccentricity of this bracing system.

Paper 155, Page 1257-1265

Ontology Models of Window Performance Characteristics for Harmonized Conformity Assessment Process

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Abstract: Conformity assessment of construction products and standardization of this process can be seen as an interface between technical and non-technical (e.g. economic, organizational, or social) considerations. It is clearly important for an efficient trade within the construction industry. However the formation and utilization procedure of standard conformity assessment needs to shift from traditional way of product performance testing to more effective and resource efficient solutions by use of advanced technology. This research investigates role of information technologies in application of conformity assessment for construction industry. The main aim is to analyze how conformity assessment can be fulfilled by development of generic product models and models for assessment processes that can support engineering solutions considering different functional and behavioural description of the modelled reality. This paper gives a case for the application of this approach as a support for window industry.

Paper 156, Page 1266-1274

Pavement Performance Models For the Ethiopian Pavement Management System

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Abstract: Performance/condition prediction is a critical element in decision making tools including Pavement Management System (PMS), Asset Management Systems, and Design Systems. PMS is a system involving the identification of optimum strategies at various management levels and maintains pavements at an adequate level of serviceability. Most performance models developed to date have had limited success outside the location they were developed. This paper deals with the development of flexible pavement roughness progression models, expressed in terms of International Roughness Index, from PMS data of the Ethiopian road network, using Multi-Linear Regression (MLR) and Artificial Neural Network (ANN) techniques. The possible use of Light Weight Deflectometer's 'surface deflection modulus' variable in the models is investigated and verified. A comparative study was also made between the MLR and ANN models, and the results from this research effort demonstrated that the ANN models outperform the MLR models.

Paper 157, Page 1275-1282

Comparison of Fuzzy Logic, Artificial Neural Network and Multiple Regression Analysis Methods in the Determination of Selling Prices of Residences

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Abstract: Housing price is a determination related to the residence properties, this determination is not just the total of the residence unit itself and the constitutional properties of the residence, and on the other hand, it is also the combination of the region's properties and location. Therefore, the determination of selling price of residence depends on several factors. These factors can be classified such as house factors, environmental factors, transportation factors and regional socio-economic factors. Additionally, they are variable and have different specific properties. At the same time, the prediction of the real selling price of residence shows variety with respect to the estate salesmen and used prediction methods. In this study, a questionnaire study has been applied including some input variables such as the properties of residence, city plans, nearness to central trade, shopping, cultural, medical, social, and training centers, public transportation systems and other factors in order to determine the selling price of residence. Data obtained from questionnaire application have been used as input variables in the methods of fuzzy logic system, artificial neural network and multiple regression analysis. The selling prices of some residences located in the different regions of Eskişehir city have been predicted by using these three methods. Prediction results have been compared to the real selling prices of these residences and the error percentages have been determined. Finally, in the end of the study, it is suggested that such methods can be capable and usable for similar applications in the determination of selling price of residence according to the obtained results from three different methods.

Paper 158, Page 1283-1291

An Information System for Design Decisions in Hybrid Projects

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Abstract: Hybrid projects refer to existing buildings that are altered through major works to accommodate and/or enhance value, function and use. The result of this process is more than an extension but a complete hybrid building. A recently completed study on the effects of the lack of as-built information for design decisions in hybrid projects led to the development of an integrated information tool based on a requirements framework. The Hybrid Project Design Decision Tool – HybridDt was developed to integrate spatial and performance information and refocusing the value stream to enhance the making of design decisions for hybrid projects. This paper presents the information protocol which forms the basis of the tool and discusses an important functionality within the tool i.e. information acquisition, storage and use. Feedback from industry practitioners on the efficiency of the tool is also briefly presented.

Paper 159, Page 1292-1299

A Decision Support System for Selecting Sustainable Material for Building Projects

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Abstract: The construction industry makes a vital contribution to the social and economic development of every country, but at the same time, its building sector has major impacts on the environment. With increased awareness and knowledge of these impacts, efforts are being made to avoid their adverse effects. Most important of these effects is appropriate selection and specification of sustainable building materials. In built environments where

ecological, health, and ethical impacts are increasingly important, often the only way to choose from many different material alternatives is by relying on ‘professional’ judgment or past experience. A more objective method is essential for evaluating the tradeoffs between alternative materials on specific projects. The method should allow comparison of not only the technical performance and costs of materials, but also the immediate and long-term impacts their use has on the finite supply of natural resources and the ongoing needs for those resources by society.

An appraisal of sustainable material selection practices and procedures with UK based architects and designers were conducted through a series of targeted interviews and questionnaire surveys. An elaborate knowledge mining on aspects of material selection underpins the development of a structured building material selection model, using the Analytic Hierarchy Process (AHP) approach. This paper presents (i) a consolidated summary of interim findings from this ongoing research exercise on building material selection aspects and (ii) some basic highlights of the proposed AHP-based material selection system for building projects.

3.3 Building Information Modeling

Paper 160, Page 1300-1308

BIM Distributed Lifecycle Data Storage on RFID Tags

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Abstract: Efficient information sharing and exchange between various players is an evident need for the highly fragmented AECOO (Architecture, Engineering, Construction, Owner and Operator) industry. Managed and easy-to-access information about facility components throughout the lifecycle should be provided for all stakeholders. BIM is emerging as a method of creating, sharing, exchanging and managing the information throughout the lifecycle. RFID, on the other hand, has emerged as an automatic data collection and information storage technology. This research proposes permanently attaching RFID tags to components where the memory of the tags is populated with accumulated lifecycle information taken from a standard BIM database that is used to

enhance different processes throughout the lifecycle. A conceptual RFID-based system structure and data storage/retrieval design are elaborated. To explore the potential benefits of the proposed approach, an example of location-related data that could be stored on RFID tags is discussed. A case study have been implemented and tested to validate the technical feasibility of the proposed approach.

Paper 161, Page 1309-1315

Integration of 4D and Model-Based Scheduling

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Abstract: This paper explores the possibility of combining two important scheduling paradigms: 4D scheduling and model-based scheduling. 4D scheduling emphasizes the animation and visualization of schedules by adding the time dimension to 3D building models. “Model-based” scheduling refers to a process where the user builds a model-based schedule by structuring it according to a well-established methodology or, in some cases, using/modifying a template schedule. One may well say that CPM represents the first generation of model-based scheduling since it directs the planner to think carefully the dependencies between activities. Some of the later developments such as LoB (Line-of-Balance), Last Planner and ALoB (Advanced Line-of-Balance) directly address the characteristics of construction operations in addition to their logic. Basically, the main objective of these

solutions is to reach an optimal solution, i.e., the longest path through a network in the case of CPM (resulting in the minimum project duration), and the optimum use of resources in the case of LoB (resulting in the minimum project duration alongside a smooth and efficient use of resources).

This paper first reviews the characteristics of the 4D scheduling paradigm and discusses the related research and development efforts. Next, model-based scheduling and its applications are described. Finally the paper focuses on the hypothetical concept of combining these two paradigms.

Paper 162, Page 1316-1323

Evaluation of 4D CAD Approach as a Construction Communication Tool

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Abstract: Construction industry as one of the related fields of IT has proved information hungry in the latter day. The mere presence of different stakeholders and their specialized sets of skills and information in this field proves the significance of communication of information. The whole process of extraction, interpretation, and communication of information from drawings in general and in complex designs in particular is a time consuming process. 4D (four-dimensional) planning as an advanced visualization technology can be utilized in increasing the efficacy of information communication among construction team members. Although helpful in understanding and evaluating information, visualization has limited usage and is not fully explored. The main objective of this research is to measure the effectiveness of communicating construction information using 4D approach compared with the traditional 2D (two-

dimensional) CAD approach. In this paper, we tried to conclude the extent to which information can be extracted and retained from 2D CAD compared to 4D CAD Model. For this purpose, a two-story house model were designed by Lego pieces. Participants in this experiment were selected from civil engineering students of University of Tehran and Iran University of Science and Technology. Half of the participants were supposed to build the house model by Lego pieces using the 2D plan and the other half using the 4D model. In both methods participants were working in groups as well as individually. The outcomes of the research revealed that all the participants outperformed using a 4D compared to a 2D model. Also it was concluded that the difference between 4D and 2D approaches can be more significant when a group participated in the experiments.

Paper 163, Page 1324-1332

An Assessment of Industry Foundation Classes (IFC) in Representing Contextual Information Required for Production Rate Estimations

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Abstract: Contextual information is needed when estimating the production rates of activities to be occurring in an upcoming project to understand the context under which previous activity production rates were achieved. These information items need to be represented and stored in a structured way as part of project histories to enable estimators to easily query and search for activities that were performed in contextual conditions that are similar to the upcoming project, so as to utilize the production rates of those activities when estimating. Previous research on contextual information showed that there are a large number of items that get to be collected and generated using a variety of hardware and software technologies. In order to enable representation of these information items in a structured way and to share this information with other software systems (such as estimating and scheduling), it is necessary to assess whether it would be possible to exchange contextual information using existing data standards. Various

data standards (e.g., CIS/2, IFC, IFD) are currently being utilized in the Architectural/Engineering/Construction and Facilities Management (AEC/FM) domain for enabling interoperability. Industry foundation classes (IFC) is a generic data standard that has the ability to represent a larger set of data items as compared to other data standards, and is being commonly utilized in the AEC/FM industry. Hence, within the context of this paper, the authors have focused on IFC data standard to assess how they are capable of representing historical contextual information required to be stored as part of project histories. Results have shown that IFCs can support most of the design related contextual information items and the current specification needs to be extended to other required contextual information items. It was also observed that, redundancies exist in IFC data representation that might hinder interoperability in the AEC/FM industry applications. These data redundancies in IFC are also highlighted.

Paper 164, Page 1333-1341

Two BIM Based Web-Service Patterns: BIM SOAP Façade and RESTful BIM

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Abstract: In the near future, Building Information Modelling will be applied in different areas of the AEC industry. Building Information Models (BIMs) will be used as resources to enable interoperability of software and 'Integrated Project Delivery based on Building Information Modelling' will be realised as a process of managing a project over a single shared information backbone. Thus, facilitating the collaborative use of shared BIMs is becoming important in parallel with the industrial demand in the field. On the other hand, in the software industry service-oriented architectures are becoming more popular in terms of enabling and facilitating, data and system level interoperability, system level integration and collaboration over distributed environments. In this context, this paper presents two web service patterns that will help in facilitating BIM based information sharing over the web and web based collaboration using BIMs. The paper starts with review on, levels of systems integration

and web services. The two web service patterns developed are elaborated on later in the paper.

Paper 165, Page 1342-1351

Towards Implementation of Building Information Modelling in the Construction Industry

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Abstract: The construction industry has been facing a paradigm shift to (i) increase; productivity, efficiency, infrastructure value, quality and sustainability, (ii) reduce; lifecycle costs, lead times and duplications. It is advocated that most of them can be obtained through BIM (Building Information Modeling). It can be defined as the use of the ICT technologies to streamline the building lifecycle processes of a building and its surroundings, to provide a safer and more productive environment for its occupants; and to assert the least possible environmental impact from its existence; and be more operationally efficient for its owners throughout the building lifecycle.

A research study has been carried out to investigate how BIM solutions are implemented by construction stakeholders in the UK, and for this matter investigated on whether a variety of methods being implemented by other countries such as Finland. The study focused on determining key strengths and identifying the challenges involved in implementing BIM in the country. This study was performed by surveys carried out in the UK with the UK construction stakeholders and by interviews carried out in Finland with Finnish construction practitioners and academics. This also captures many other similar studies been conducted by individuals, research groups and organisations around the world during last five years and such content have integrated within this paper as relevant.

Paper 166, Page 1352-1361

A Model for Increased Collaboration in Construction

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Abstract: The paper outlines a decision support environment that actively supports collaboration during decision making and problem solving. A complementary partnership is formed between computer agents and human agents; the one bringing selected intelligence to the solution process from “unlimited” multi-domain knowledge sources, the other bring human cognitive rationality. In particular the system proposed articulates how domain knowledge and know-how can be shared thereby creating a truly integrated construction team. The author's investigation measured the views of practitioners in the main building professions; architecture, engineering and construction management before proposing the decision support system. The conclusion of the work is a conceptual model; a definition of the contractors' construction management computer agents and a specification based on scenarios of how these agents would interact with design agents.

Paper 167, Page 1362-1369

Lessons Learned from Generation of BIM for Construction Management: Case Study

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Abstract: Building Information Models (BIMs) are beginning to be utilized for facilitating effective communication of accurate data about projects throughout their lifecycle. Such models are envisioned to be a common medium to store and exchange information amongst various stakeholders involved in a project by enabling the creation and reuse of information. As interest in the usage of BIM grows in the industry, a need emerges to understand what are requirements in terms of time and effort necessary to generate a BIM that is useful for construction management purposes. With the aim of identifying challenges associated with the creation of a BIM, the authors conducted a case study in which a five storey commercial building was

modeled at the beginning of its construction period. Core and shell elements were modeled with close interaction with the contractor to understand the level of detail that was needed by that contractor; which resulted in a model containing 6,006 components. During modeling, the amount of time needed for creating and maintaining of the model was also captured so as to be able do an analysis of the requirements for creating and maintaining BIMs. In this paper, the authors present the lessons learned from this building information modeling experience, with a specific emphasis on the issues identified related to the creation of, and level of detail that was needed from, the model.

Paper 168, Page 1370-1377

Whole Building Design Approach for University Facility Managers: A Template Using Building Information Modeling

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Abstract: The use of Building Information Modeling (BIM) has significantly influenced workflow in the architecture, engineering and construction sector. This technology can be used from inception of a project all the way through facility maintenance and operation. This paper examines the processes of design, construction and maintenance of facilities at XXX University in USA. The use of BIM in implementing the ‘Whole Building Design Guide’ in the processes of design, construction and maintenance of a facility at a university is examined. The offices of ‘campus planning and space management’, ‘design and construction services’, ‘facility maintenance and operations’, ‘life safety’ and the ‘university administration’ play a key role in the life of a university building. The processes and internal interactions between the various departments are examined by conducting interviews of key personnel. A flow chart analysis of all processes will be used to document the workflow of the various departments. Strategies for the successful implementation of BIM for facility management are presented.

Paper 169, Page 1378-1386

Building Information Modeling (BIM): Case Studies and Return-on-Investment Analysis

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Abstract: Building Information Modeling (BIM) is considered as one of the most promising developments in the AEC industry. It helps architects, engineers and constructors to visualize what is to be built in a simulated environment and aids in identifying potential design, construction or operational issues. Recent studies have indicated that BIM is certainly viable and offers many realizable advantages over traditional CAD systems. Though a wealth of information on BIM benefits is available in the recent trade, commercial and technical journals, very few studies have attempted to present data on the time and cost benefits which can be realized through BIM. This paper, via three case studies, presents the quantitative data to illustrate the cost and time savings achieved by developing and using building information models at the various project life cycle phases. In addition, using the data collected from 10 projects, the BIM Return on Investment (ROI) is calculated. It is found that the average BIM ROI on these projects was 634% which depicts its potential economic benefits.

Paper 170, Page 1387-1394

Current Status of Building Information Modeling (BIM) Adoptability in the U.S. Electrical Construction Industry

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Abstract: The electrical construction industry traditionally relies on 2D/3D drawings to layout, design, estimate, and install power and communication systems in building facilities. With the advent of Building Information Modeling (BIM), electrical contractors have begun to experience its potential benefits. However, the scale of BIM adoptability in the U.S. electrical construction industry and its impact on electrical design and construction are still unknown. Keeping these objectives in mind, this research study was carried out with the support of National Electrical Contractors Association (NECA), USA. A

questionnaire survey targeted at NECA members was conducted to collect the necessary data. The results indicated that about 20% of the companies, who participated in this research study, are using BIM technology in their projects. Most of these companies are medium to large size in terms of annual revenues. These companies are mostly using BIM technology for clash detections, visualization of electrical design, space utilization, and partial trade coordination in commercial and healthcare projects. The majority of participants reported some-to-significant cost and time savings and quality improvements. The most common reasons for not using BIM were found to be lack of BIM knowledge and technological experience, software compatibility issues and high initial investment costs.

4. Construction Technology

4.1 Engineering Design Issues and Solution

Paper 171, Page 1395-1402

Performance Based Lab Tests to Predict Pavement Fatigue

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Abstract: As roads are subjected to high traffic loads due to the strong growth in heavy vehicle traffic and new trends in the automotive and tyre industries, the traditional asphalt mix tests are often inadequate for a reliable prediction of the in-service performance of flexible road pavements. With the new generation of performance-based test methods (PBT) the complex thermo-rheological properties of bituminous bound materials such as asphalt concrete (AC) can be obtained. On the basis of PBT performance indicators like low-temperature cracking, high-temperature rutting and fatigue at intermediate temperatures are assessed. This paper presents the principle of the so-called 4-point-bending-beam (4-PBB) fatigue test as one PBT to predict pavement fatigue. Furthermore it is shown, how results from this test can be used in combination with computer-based simulations to quantify the effects of different tyre types and wheel configurations on pavement fatigue. In an ongoing research programme extensive 4-PBB-tests are carried out on different AC mixes for base layers at various temperatures and frequencies to obtain

Woehler-curves. At the same time, computer-based linear elastic simulations are performed. These simulations are carried out on two different constructions, different tyre types (standard and wide base) and wheel configurations (tyre load and pressure). The strains on the bottom of the bituminous bound layers are taken from the simulations and used in combination with the Woehler-curves to evaluate the life-time in permissible load cycles for different tyre configurations.

Paper 172, Page 1403-1409

Properties of Recycled Aggregate Concrete with Various Aggregate to Cement Ratios

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Abstract: Waste from construction and building demolition work constitutes about 44% of the total amount of waste generated each year in Australia and about 68% in Southeast Queensland (SEQ). The use of recycled aggregate (RA) from concrete waste presents some important environmental and construction engineering issues that need resolution. With poor strength and high water absorption rate, RA is rarely used in high-grade concrete applications; it is only restricted for use in roadwork sub-base, low-grade pavements, retaining walls and footpaths. This paper summarises experimental results on compressive strength, indirect tensile strength and flexural strength of recycled aggregate concrete (RAC) with different aggregate to cement ratios between 3.0 and 6.0 for 30% RA replacement compared with normal aggregate concrete (NAC). Water to cement ratio for all types of concrete is 0.45. The RA samples used are collected from a centralized recycling plant in Southeast Queensland, Australia. All the concrete mixes under investigation achieved at least 35MPa in compressive strength and 3.3MPa in indirect tensile and flexural strength for 28-day curing days. It is also found that the higher

the aggregate to cement ratios, the lower the RAC quality. Recommendation for the aggregate to cement ratio for RAC production is about at least 6.0 for general structural concrete.

Paper 173, Page 1410-1419

Experimental and Numerical Investigations of Steel Tension Members with Holes

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Abstract: This paper discusses the experimental and numerical investigations conducted on steel tension members, in order to develop appropriate material stress-strain relationship for numerical analysis, which can capture the behaviour of structural steel including the fracture. Twenty eight tensile coupons were obtained from beam sections made of two different steel grades; ASTM A992 steel and 350W steel. The test program considered flange and web coupons, both solid and perforated samples (Net area-to-gross area A_n/A_g ratio 0.9 to 0.5) having different diameter holes in the middle region. The experiments on solid coupons provided the engineering stress-strain relationships until fracture. These relationships were converted to true stress - true strain relations up to ultimate strength. A unique material constitutive relation for post-ultimate region, which is expected to capture the behaviour of the coupons up to fracture, was derived by simulating these tests using Finite Element (FE) analyses. This material constitutive relation so derived was then used to predict the load-deformation behaviour of coupons with a hole in the middle region subjected to direct tension loading. The FE predictions for perforated tension coupons agreed well with the corresponding experimental results.

Paper 174, Page 1420-1426

Application of Ultrasonic Measurements for Determination of Setting and Hardening in Cement Paste

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Abstract: Concrete setting and hardening processes are the most critical phases during construction works, influencing properties of a concrete structure. The initial set is important as it provides an estimate when concrete has reached a point that it can no longer be vibrated without damaging concrete. The point at which final set occurs is important since it provides an estimate when the development of concrete strength and stiffness starts. In this study, experimental work is performed under laboratory conditions to identify the setting time of cement paste using ultrasonic waves. Correlation between the ultrasonic wave parameters (speed, amplitude and energy) passing through the fresh cement paste and setting time determined using the Vicat test method is analyzed. A method of acoustic emission is also used and acoustic signals recorded in cement paste during hydration are presented.

Paper 175, Page 1427-1434

Numerical Study of the Base Fixity

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Abstract: Details of a numerical model of base column are presented to study the actual behavior. Different configurations of steel column base were investigated. The base fixity was investigated by modeling analysis using software program ANSYS. The rotational stiffness-moment relationships are established for each type of base fixity until failure of base. The investigation of these relations indicates that the behavior of the base column divides to three regions. The first region is elastic, the second is inelastic and the last region is plastic. The analysis

of the first zone (elastic zone) is considered sufficient for use of the initial linear response where the design processes is carried out. The relationships between the ratio of the base size and the rotational stiffness of column are established. Using these relationships, elastic prediction stiffness formulae for the base fixity were initiated. The suggested equations were compared with the recent methods. The suggested rules show good accuracy and adequate values with the accurate behavior of the base column connections.

Paper 176, Page 1435-1442

Strength and Permeability of Concrete in Constructing Oil Storage Tanks

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Abstract: Nowadays, oil storage tanks play a strategic role in industries; therefore, it is essential to consider required facilities for them against explosion and fire problems. This can be achieved by using an appropriate concrete to ensure security and durability; furthermore, economical benefits, possibility of construction of buried tanks and increase of concrete strength without structural flexibility reduction can be gained in comparison with steel tanks.

Effect of crude oil on concrete has been partially studied in the past. The concrete used in constructing oil storage tanks should have some characteristics such as low permeability and enough durability against petroleum substances along with salty or sea water; therefore, silica fume was replaced for part of cement in concrete.

In this paper, we can see the results of compressive strength and permeability tests on ordinary and silica fume containing specimens with two water-cement ratios (0.4 and 0.5) which are cured in different environments (water and oil).

According to the test results some recommendations can be given as follows:

- In order to achieve the characteristic strength of concrete, there should be at least 28 days gap between pouring of concrete and filling the tanks with oil.
- Replacement of 7.5 % of cement with silica fume increases the compressive strength of concrete noticeably; furthermore, it decreases the concrete

permeability coefficient for 100 times; therefore, to prevent concrete or steel bars corrosion and also leakage of oil from the tanks, it is recommended to use silica fume in constructing oil storage tanks.

Paper 177, Page 1443-1448

Draught Year Management at 2008 in the Karun and Bahmanshir Rivers to Control the Fresh Water Reserving and Sea Water Biologic Impacts

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Abstract: Draught year 2008 is scheduled to manage the Karun fresh water by the composite earth dam construction with distance 8'500m from TB (Three Branch). In addition, sanitary water will be pumped from the end of Mared channel into Khorramshahr pump station through steel pipeline and submerge siphon. In this condition, Mared pump station will be transferred the Karun fresh water into Bahmanshir River more than 60 cubic meters per second. The normal discharge of Karun River in the wet year is 240 cubic meters per second. It appears 3/4 discharge discounting. Bahmanshir needs to prevent against the sea water advancing through 35 cubic meters per second fresh water flow. Remain flow current 25 cubic meter per second will be served by irrigational areas in the banks of the Bahmanshir River. In normal years, discharge current is more than 75 cubic meters per second. It appears 3/4 reduction and loss in agricultural productions. Solutions methods will be defined to increase the water level at upstream of Karun river by the three temporary dams which could be constructed from Ahvaz to Khorramshahr with the Karun River length 120km.

Paper 178, Page 1449-1456

Steel Buoyancy of Cast-in-Place Piles, Study and Behavior through Mistake Design of Longitudinal Steel Bars Area and Basket Spiral Mesh Pitch

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Abstract: Some regions require deep foundation in the SW of Iran. Low resistances soils are forced to build various types of steel pipe, concrete precast and cast-in-place piles. Cast-in-place piles are used through suitable section area and required length in depth that length will vary from 10m to 45m. Longitudinal steel bars could be floated in the well to lift the spiral basket by injection pipe pressure of fresh concrete. Buoyancy forces could be exerted to destroy the top platform and steel mesh. Sometimes it is observed to lift the loader wheels and steel falling hammer. This event appears the negative psychological effects in the workshop. Expert workers are believed uncertainly ideas that unknown problems will refer to concrete mixture, drilling without casing and liquid circulation of pile hole. Also, the main problem will refer to the spiral mesh and steel bar section area. Steel floating could be interpreted by pervious problems. Solutions will be suggested to control the ρ (relative steel section area) through the length of the pile and spiral could be started at 100cm above the pile tip. Fresh concrete slump will be used more than 25cm. Circulation will be continued to end of concreting.

Paper 179, Page 1457-1467

An Investigation on the Behavior of One-layer and Two-layer 3D Panels in Shear and Flexural Test

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Abstract: The 3D panels are a new system of construction. This system is used as wall and ceiling in buildings. The structural behavior of 3D panels is

dependent on the strength and rigidity of connector elements. In this article flexural and shear tests have been conducted on six 3D panels. The results have been compared with results of finite element software, ANSYS. The details and results of the test program are described, and the observed behaviour patterns are discussed.

Paper 180, Page 1468-1475

A Revolutionary Concept in PSC Bridge Girder Design Having Holes in the Web

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Abstract: Prestressed concrete (PSC) I-type girders have been widely used at the superstructures of bridges due to the simple design and low maintenance cost. Nevertheless, the traditional I-type PSC girders are limited in their length due to allowable stress limitation in the member. In this study, two revolutionary concepts have been combined to make longer bridge spans possible upto about 70 meters; 1) A numerous number of holes was introduced at the web of girders. Some of the anchorage devices was moved into the holes, and the magnitude of negative moment developed at the girder ends was cut down and stress concentration was reduced. 2) Prestressing force was introduced through multistages. This concept of incremental prestressing overcomes the prestressing force limit restrained by the allowable stresses at each loading stage. A full scale 50 meter long girder was fabricated and tested. Test results showed that the Holed Web Prestressed Concrete (HWPC) girders had a great advantage against conventional I-type concrete girders for long span bridges.

Paper 181, Page 1476-1482

Connector Stiffness of 'Peva-Cemboard' Screwed Connection in Profiled Steel Sheet Dry Board (PSSDB) Panel

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Abstract: The Profiled Steel Sheet Dry Board (PSSDB) composite panel consists of profiled steel sheet connected to dry board by self-drilling and self-tapping screws. The mechanical connectors, namely the screws, serve to transfer the shear force between the two layers. When a PSSDB floor panel is loaded, the connectors, dry board and profiled steel sheet around the connectors deform, thus inducing slip between the layers. The amount of slip, which reflects the stiffness of the connection, determines the degree of composite action and the overall performance of the floor panel. The actual connector stiffness is thus a very important parameter in the finite element analysis of the floor. The stiffness varies according to the type of screw and spacing between screws, dry board and profiled steel sheet used and needs to be determined empirically for each new combination. This paper describes a series of experiments to determine the connector stiffness, known as the push-out tests for three combinations of profiled steel sheets and dry boards. It is basically a compression test to determine the load versus slip curves. Nine samples were tested; the ultimate loads and modes of failure were observed. The stiffness values were determined from the slope of the graphs. The results showed that the Peva-Cemboard combination has a higher stiffness than that of the Peva-Plywood, but the latter recorded a higher ultimate load. The failure modes consist of a mixture of sheared or pull-out of screws (inclination failure), tearing of profiled sheeting and crushing of dry boards. All the stiffness values are within the range of previous findings and can be used in the finite element analysis of the floor model.

Paper 182, Page 1483-1491

Self-Compacting Paste Systems Containing Secondary Raw Materials

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Abstract: Self-compacting paste (SCP) systems are the vehicles for the transport of aggregates within self-compacting mortar and concrete systems. SCP systems incorporating different types of cements and secondary raw materials (SRM's) were studied for SRM particle characteristics and powder parameters including water demand (WD), setting times and flow. Strength, early volume stability and microstructure of SCP systems are also reported. The results showed that SRM particle characteristics have a significant bearing on the system's WD, super-plasticizer demand (SPD), strength and microstructure. Inclusion of pozzolanic SRM's in SCP systems as ten per cent cement replacements increased the strength and durability due to three parallel operative mechanisms of filler (physical), hydration and pozzolanic actions (chemical).

Paper 183, Page 1492-1500

Mechanical Characterization for Mortar for Masonry

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Abstract: The Eurocode 6 defines classes of mortars resistance which are based on the minimum compressive strength of mortar at 28 days after casting and suggests reference compositions for obtaining such classes.

To incorporate in the National Annex of Eurocode 6, we have studied different mortar compositions usually adopted in Portugal. The mortars composition was based on the Bolomey's formula.

The mechanical characteristics of the mortar, were evaluated by laboratory tests: consistence and air content (fresh mortars); compressive and flexural tensile strength, Young's modulus, shrinkage and fracture energy (hardened mortars).

In the first phase of the study were considered six different sands: three artificial (AE - left to the limit - very fine sand, A - within the limits and AD - right to the limit - very coarse sand) and three natural (NE - left the limit - very fine sand, N - within the limits and ND - the right to limit - very coarse sand).

The second phase of the study was only with the artificial and natural sand within the limits, A (artificial sand) and N (natural sand). For the same classes of resistance, the natural mortar of sand has almost better results than mortars of artificial sands; the mortars whose binder was only the cement, showed quite reasonable resistance, as well as the mortar in which was used the hydraulic lime; the mortar of cement and hydrated lime were the ones who presented lower resistance. The mortar of artificial sand has higher values of fracture energy compared to mortar with natural sand.

Paper 184, Page 1501-1509

Role of Wind Pressure Data Probabilistic Interpretation in Wind Tunnel Tests on Tall Buildings

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Abstract: Implanting tall buildings, the present and future solution for the development of many big cities in the urban environment, is a design process marked by the effects of alteration of the local wind flow pattern, affecting the sustainable concepts of the investments. Many of these effects have being put in evidence up to now through studies in atmospheric boundary layer tunnels and the research in the buildings aerodynamics' domain is enlarging the directions and refining the methods of modelling and measurements.

A research program was developed during 2007-2008 in the laboratory of Buildings Aerodynamics of the Faculty of Constructions and Building Services and along refining the modelling of atmospheric boundary layer in wind tunnel, local pressure measurements on the walls of rigid models of high buildings were done. In order to validate the results one must use modern methods of calibration of the gathered data.

The paper presents the statistic analysis of aerodynamic pressure coefficients data and the results of this analysis. The conclusions drawn are very important for the future tests in the tunnel and also for the design of high rise buildings in our country.

Paper 185, Page 1510-1517

Technical and Economic Analysis for Optimum Condition of Aggregate Recycled from Unused Ready-Mixed Concrete

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Abstract: The objective of this study is to find the optimum condition of aggregate recycling from unused ready-mixed concrete in order to reduce the quantity of waste concrete and the expenses of waste treatment. Moreover, the environmental impact from the abolition of waste concrete can also be reduced, and the economic aspect of such reduction has been analyzed. According to the testing quality on attribute of gradation and dust volume of gravel and sand derived from unused ready-mixed concrete, the property testing result met the standard range and was suitable for using as a concrete production material. The experimental design was conducted to find the optimum proportion of recycled and new gravel and sand. The proportion of recycled gravel and sand at the percentage of 0, 20, 40, 60, 80, and 100 were varied. From the result of this experiment, the optimum percentage of recycled gravel and sand should not exceed 60 percent. As for the economic feasibility study at the 10 years of project life and a minimum attractive rate of return of 20 percent, the incremental investment analysis revealed the net present value at \$US 86,000 whereas the internal rate of return of the incremental investment was 50.88 percent per year. The payback period was 2 years and 11 months. Regarding the sensitivity analysis, it showed that changing of gravel and sand price in the range of +/-25 percent would only slightly influence the internal rate of return, which did not affect the investment decision. Thus it could be derived from the result of this study that the recycling of aggregate recycled from unused ready-mixed concrete, at optimum condition, was technically and economically feasible for investment.

Paper 186, Page 1518-1525

The Effects of Limestone Powder and Pulverized Fuel Ash on Compressive Strength of Casting Concrete in Hollow Core Slab Manufacturing Process

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Abstract: The proportions of substitute substances in concrete mixture depend upon the required properties of product produced and anticipated acquisition costs. Limestone powder and pulverized fuel ash are the potential substances widely used in manufacture of concrete products. The objective of this paper was to analyze the effects of limestone powder and pulverized fuel ash treated as substitute substances of Portland cement in terms of compressive strength of concrete casting in hollow core slab manufacturing process of the selected case study. Design of experiment with single and two factors analysis was employed to analyze the main effect as well as interaction effect of co-substance. The relationship between compressive strength and the proportion of substance substitution was also analyzed by the regression analysis. The findings revealed limestone powder and pulverized fuel ash could vary individually with 0-15% and 0-20% by volume, respectively, without any effects to the quality of the final product. And no interaction effect between them in enhancing the compressive strength of the concrete products was significant revealed. Based on the economic point of view limestone powder was the challenge alternative filler to the manufacturer with attractive cost savings.

Paper 187, Page 1526-1535

Utilization of High Volume Fly Ash Cement Paste in Civil Engineering Construction Sites

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Abstract: End-products made with high volume fly ash (HVFA) have superior engineering properties, as well as economic benefits. The research was carried out to investigate the effects of using HVFA on strength properties of construction materials. Physical and mechanical tests were conducted on the $\Phi 50$ mm/100 mm specimens. Physical tests considered were apparent specific gravity, water absorption and dry unit weight. Mechanical properties considered were compressive strength, and flexural strength. In general, strength of HVFA was considerably affected by amount of fly ash. Also, the strength properties for the 20 % fly ash mixtures were either comparable or superior to the no-fly ash concrete. All the mixtures, with and without fly ash, tested in this investigation conformed to the strength requirements for excellent quality structural grade concretes. Based on the test results of this study indicates that the engineering performance of the final product can be adequate for using them in the manufacturing of construction materials and various civil engineering applications such as construction of structural fills, embankments, grouting injection, road bases and sub-bases.

Paper 188, Page 1536-1543

Development of Vacuum / Pressure Bagging System for FRP Repair

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Abstract: Fiber reinforced polymers (FRP) are widely used in the repair and rehabilitation of structures. Recently, their application has extended to the repair of damage caused by corrosion of steel in concrete. In any strengthening application, the bond between FRP and its substrate is of paramount importance for ensuring proper load transfer. This requires continuous intimate contact between the resin-saturated fibers and the substrate as the resin cures. Such contact is generally maintained except in situations where gravity effects create tendencies for separation. This occurs in the repair of vertical elements such as columns or soffit regions of slabs. Traditional methods of ensuring contact utilize plastic shrink wrap or duct tape. However, the pressure is variable and bond can be poor. Tests have shown that sustained, uniform external pressure can improve FRP bond. Pressure bagging and vacuum bagging are well established techniques

routinely used in the fabrication of FRP parts by the aerospace and automotive industry. Their extension to infrastructure applications has been limited. Indeed, no applications of pressure bagging had been reported in the literature until last year. This paper provides an overview of the development of pressure bagging and vacuum bagging systems intended for the repair of piles in tidal waters. The system is inexpensive, easy to use and versatile and can be used for both above and below water applications. Results from destructive pullout tests show that bond is significantly improved by these systems.

Paper 189, Page 1544-1552

Effect of Kinematic Viscosity of Hydrocarbon Contaminants on Shear Strength and Compressibility of a Well Graded Sandy Soil

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Abstract: This study investigates the effect of contaminating, a well graded sandy soil, with lamp oil, on some selected geotechnical properties of this soil. In a previous study, the effect of contaminating the same type of soil, with diesel oil, on the same geotechnical properties was studied. These two studies are part of an ongoing research that aims at studying the effect of contamination of different hydrocarbons on the geotechnical properties of this soil.

The effect of kinematics' viscosity of the studied contaminants was made through comparing the behavior of shear strength and compressibility before and after contamination. The results indicate that the decrease in kinematics' viscosity, as exemplified by lamp oil, has resulted in decrease of both shear strength and compressibility of the contaminated soil. However, this decrease was less pronounced in the case of diesel oil. More than three hundred direct shear tests, ninety five one-dimensional compression tests, and one hundred proctor compaction tests were run. Five levels of relative densities were utilized; eight percentages of mixing proportion of each contaminant at variable levels of degree of saturation were adopted. Other parameters such as the hydraulic conductivity and

behavior under cyclic loading are recommended for further studies.

4.2 Innovative Construction Technologies and Techniques

Paper 190, Page 1553-1562

Economic Evaluation of Paste Thickener Construction in Optimal Management of Industrial-Complex Water Cycle

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Abstract: Using close water cycle in industrial complexes has a high level of importance from different aspects. Supplying water from scarce fresh water resources (river and groundwater) has irrecoverable effects on environment as well as extraction of that and transiting it to the plant is not economical. Versus traditional methods for reproducing of return water such as tailing dams, these days the state of the art methods is used such as paste thickeners (PT) – costly facilities that thicken the tailings by taking its water for reusing in the plant. In this research optimal usage of variable-capacity PT in close water cycle of a copper complex have been evaluated economically, using Net Present Value concept with the combination of Tabu search – one of the most powerful meta-heuristic methods. Results show 50% reduction in operation expenses by using variable-capacity PT instead of conventional methods.

Paper 191, Page 1563-1570

Development of a New Composite Flooring System Based on Improved Profiled Steel Sheet Dry Board (PSSDB) System

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Abstract: This paper presents an experimental study on the behaviour of a double skinned 'Profiled Steel Sheet Dry Board (PSSDB)' composite panel system. This newly proposed system is basically an extended structural system based on a previously developed single skinned PSSDB system. The basic components forming the system consist of a single profiled steel sheet attached to a double-skinned dry board layers, also by self-drilling and self-tapping screws. The experimental structural stiffness of the proposed floor system is compared with simple theoretical prediction. The experiment is also performed to identify the behaviour of the system until failure using full-scale model in the laboratory. Two samples using different types of Profiled steel sheeting (Peva 45 and Bondek II, both having 1 mm thickness) were tested with the distance between screws of 200 mm for each sample. The dry board is 9 mm thick *Primaflex*. *Primaflex* is a newly introduced dry board as an alternative to an earlier widely used Cemboard. The dimensions of the simple supported models are 2000 mm (span) x 850 mm (width). It can be concluded that the use of double layer *Primaflex* with Bondek II is able to increase the stiffness and load bearing capacity of the system compared to that using Peva 45. It was found that the maximum load of Peva 45 and Bondek II were 24.1 kN and 41.6 kN respectively. The value of theoretical stiffness was found to be higher than the experimental stiffness; for Peva 45, the values were 229.0 kNm² and 196.6 kNm² respectively, and for Bondek II, the values were

536.6 kNm² and 304.7 kNm² respectively. These discrepancies are due to the simplification made in the theoretical prediction by assuming that the system is acting in a full interaction mode, whereas in reality, it is behaving in partial interaction behaviour. Therefore, it can be concluded that the PSSDB floor system comprising Bondek II does have great potential to be used as load-bearing structural floor system.

Paper 192, Page 1571-1575

Excavation of Ankara Metro Shaft by Using Inclined Piles

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Abstract: Underground structures are the most challenging construction part of metro projects. Basically there exist two types of underground structure in a metro line: Stations and tunnels. These structures can be built by either cut-and-cover or tunnelling methods. In a cut and cover method, temporary supporting of the excavated sections of the ground is a major problem especially if ground conditions are unfavourable and if the excavations are too deep and to be executed under water table. In this paper the excavation method of the metro shaft structure incorporating 20 degree inclined concrete piles which was used for the first time in Turkey is explained.

Paper 193, Page 1576-1580

Alternative Waste Aggregates in Road Base Materials

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Abstract: This paper addresses the need to use limestone rock aggregates, Granulated Blast Furnace Slag (GBS) waste materials together with recycled aggregates waste dust as a replacement for primary crushed rock aggregates in road base materials.

Using these materials at high volume will generate a new market for waste producers and waste management companies and will reduce the burden of landfill and the associated environmental and social impacts.

The re-use of wastes in high-value applications and reduced primary aggregate consumption will increase resource efficiency in the field of pavement construction. This work will have a direct impact on two quality of life indicators: “consumption of primary aggregates per unit value of construction” and “ratio of secondary to primary aggregate consumption”.

In this study up to 10-20 % of the primary aggregates were replaced with dust recycled waste materials. Early laboratory results indicate that, this approach can also offer outstanding increase in the road base material stiffness and produce cost savings.

Paper 194, Page 1581-1587

Contour Crafting: A New Automated Construction Technology and its Benefits to the Environment

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Abstract: Contour Crafting (CC) is a layered fabrication technology using robotic arms and extrusion nozzels, developed at the University of Southern California. The potential impact of CC in construction became evident after successful experimentation with various construction materials such as clay, plaster and concrete. The technology is at a stage where complex shapes such as walls and domes have been constructed. The objective of this paper is to quantify the comparative life-cycle embodied energy and CO₂ emissions of a concrete frame house built by two different methods: the automated CC technology and a standard manual construction using Concrete Masonry Unit (CMU). Our comparative life-cycle models (LCA) indicate that CC results in a reduction of 72% in total CO₂ emission compared to the manual CMU construction method. Also, the total embodied energy of a CC building is reduced by 37% over the CMU construction method. Our calculations also indicate a ratio of 5 to 1 reduction in solid waste generated by CC compared to CMU on a life-cycle basis. LCA model assumptions and future research directions are discussed

Paper 195, Page 1588-1594

Waste Rubber Aggregates for Use in Asphalts: A Laboratory Study

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Abstract: The paper presents laboratory test results on bituminous mixtures containing upgraded waste rubber coarse and fine aggregates compared with control mixtures.

The mixtures incorporating rubber and fine waste rubber aggregates were designed as potential playground surfaces and contain higher levels of bitumen binder than the standard mix. The combined influence of the binder content and alternative aggregates is to reduce the stiffness of the asphalt and make the pavement suitable for children to play and walk on safely.

The rubber and fine waste rubber aggregates were pretreated using LJMU additives[©] for improving the bonding/ adhesion between the waste aggregates and the bituminous binders and to reduce the swelling of these materials when they come in contact with bitumen at high temperatures.

Repeated load axial and repeated load indirect tensile tests were performed on the bituminous mixtures.

The test results are encouraging, showing significant improvements in the bond strength between the aforementioned waste aggregates and bitumen in the tested mixtures. This offers the prospect of using these materials in low traffic load bituminous pavements *e.g.* school playgrounds, pathways, leisure areas etc. The applications of such materials in high traffic load bituminous pavements should be the subject of further investigations.

Paper 196, Page 1595-1602

Saw Blade Lifetime Extension for Cost Saving and Productivity Improvement

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Abstract: This study was setup to evaluate and qualify for production the new approach of saw blade lifetime extension or extended the usable length on wafer saw blade model X that promised substantial cost reduction as compared to the original of usable length control at maximum 280 micron. Since the trend at the study plant is towards assembling memory products with thinner thickness when compared to a few years ago, i.e. the extension of usable length are evaluated especially on 170, 250 and 280 micron wafer thickness, and also gains the benefit for the increment time for machine utilization. The focus of this evaluations was on comparing the impact of the increasing of usable length of saw blade at related operations—i.e., wafer saw, die attach and test. Issues related to usage of the extended length studied included the blade properties on diamond distribution study on the blade itself as well as the Finite Element Analysis (FEA) on the blade vibration at different length. The diamond distribution showed consistency trend along the blade from the start to the end of blade. The Finite Element Analysis (FEA) result showed the shorter of blade length or the extended part of blade that was used can create smaller vibration than the original length which may infer better on saw kerf quality. Besides, this evaluation also included the kerf quality and topside chipping at wafer saw operation with various interested factors—i.e. Machines, Wear, Spindle RPM, Feed rate and wafer thickness by using Half-Fractional Factorial design. The result showed that feed rate is the most influenced factor in saw kerf quality. Confirmation runs indicate that wafer saw and die attach can achieve at 100% yield.

Paper 197, Page 1603-1612

Proposal for Evaluation Management of Concrete Block Pavement (Interlock Pavement) with new Pavement Condition Index

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Abstract: There are several procedures for evaluating flexible (asphalt) and rigid (concrete) pavements. The most world wide known procedures are: Pavement Condition Index (PCI), Pavement Condition Rating (PCR), the Aashto Present Serviceability Index (PSI) and the German Guidelines for Pavement Maintenance Planning (*RPE – Stra 01*). Until now there has been no single procedure for evaluating concrete block pavements (Interlock Pavements). This research shows for the first time how to evaluate these pavements using new pavement condition index, which depends on determining distress types and own deduct value curves. Then, the research provides important conclusions and recommendations for those concerned with concrete block pavements and enable them to take immediate decisions regarding necessity of maintenance measurements.

Paper 198, Page 1613-1621

Road Pavement Density Measurement by Using Non-Destructive Ground Penetrating Radar System

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Abstract: This paper presents the development of Ground Penetrating Radar (GPR) system based on the electromagnetic wave reflection in order to determine the density of road pavement. The proposed method is simple, fast, non-destructive and

within an acceptable accuracy of determining the road pavement density. The predicted signal attenuation from the theoretical analysis is compared with the signal attenuation measured from the laboratory experimentation. The comparison produces the relative error between these two results and it is used in the optimization. The best theoretical model with smallest mean error from the three existing GPR Mixture Models (GMM) has been improved in optimization process. The finding from the optimization process suggested that three additional constant parameters which are Volume factor, Permittivity factor and Attenuation factor need to be included to improve the existing GMM model. A field test had been conducted as a reliability analysis to validate the optimized GMM model. From the field test, it shows that the proposed GPR system works well with an error range from 0.29% to 0.96 % for nine locations. Finally, a complete GPR system has been developed based on the optimized GMM attenuation curve to predict the density of a real road pavement.

4.3 Sustainable Construction Techniques

Paper 199, Page 1622-1628

Australia's First 6-Star Green Education Building: Construction and Services Technologies

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Abstract: Green Star is a voluntary environmental rating scheme that evaluates the environmental design and achievements of buildings. It was developed by and is administered by the "Green Building Council of Australia" (GBCA). Green Star covers a number of categories that assess the environmental impact that is a direct consequence of a projects site selection, design, construction and maintenance. The nine categories included within all Green Star rating tools are management, indoor environment quality, energy, transport, water,

materials, land use/ecology, emissions and innovation

The new School of Sustainable Development completed in mid-2008 is the country's first 6-star rated green education and is a 'pilot' project for all similar education buildings in the future. This paper presents a summary of the important construction and building services systems in the building that contribute to its premier green rating. A distinct feature of the building is the monitoring of the various systems in the building continuously and some of the results of this monitoring will be presented and analysed.

Paper 200, Page 1629-1636

Formulation of a Measurement System to Determine Sustainability of Building Projects

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Abstract: During the last two decades, green building movement has come to the forefront of building industry. Consequently, several significant building environmental assessment methods have emerged in different parts of the world providing diverse perspectives on the measurement of environmental impact of building projects. Analysis of current literature and research on green buildings revealed the need for broadening the scope of building performance assessment methods to fall within the main spheres of sustainability – environmental, social and economic norms. This paper examines the possibility of evolving an assessment system of indicators expressing the complex relationships between environmental, social and economic domains of sustainability which would effectively measure the sustainability performance of building projects. It is an exercise involving the development of a definition for sustainable buildings, several root cause analyses of sustainability issues to identify the causes /criteria that require attention in building projects, and the enhancement of these criteria to incorporate sustainability objectives, resulting in a set of indicators. Determination of criteria and value for

each indicator would eventually culminate in an index for assessing sustainability of building projects.

Paper 201, Page 1637-1645

Construction and Demolition Waste Usage Possibilities

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Abstract: Construction and demolition waste with certain treatment procedures can be effectively used for different applications – as material for roads bearing layer as well as an addition for various concrete and asphalt mixtures. It is well known that this usage directly affects on environmental protection, saving the natural resources. In order to achieve necessary requirements for an appropriate disposal, recovery and storage of construction and demolition waste, certain methods and procedures should be specified.

In this paper, there will be presented requirements and recommendations for using raw material obtained from C&D waste, and in particular characteristics of recycled aggregate. Physical and mechanical properties of recycled aggregate depend on waste origin, separation procedures and material treatment. Possibilities of its usage mostly depend on user requirements and for that purpose, specific properties of recycled aggregate in comparison with aggregate from natural resources should be clearly defined. In general, the whole system of C&D waste management should be supported by legislation relating to the building design and issuance of location and building permits. It is necessary in order to increase use of environmentally friendly materials, to discourage generating of new construction waste, and to include construction waste management options in design documents.

Paper 202, Page 1646-1654

Green Bridges for Minimizing Fragmentation of Landscape

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Abstract: Sustainability can also be understood as long-term compatibility. Its basic pillars are ecological, economical and social-cultural. From the ecological point of view there are three basic protection elements: protection of sources, ecosystems and human health. The use of natural sources must be evaluated not only from the point of view of price and quality but also it's necessary to consider all impacts on surrounding environment. In case of road structures, among which belong motorways and highways, it is necessary to deal with problems of possible defragmentation of biotopes leading to isolation of partial populations. Special corridor structures – so called *ecoducts*, which serve towards minimization of population fragmentation, are suggested in order to preserve current possibilities of animal migration. In the process of design of ecoducts there is a great necessity of careful evaluation of what kind of animals they are intended for, further their ground location, facture, adjustment of surrounding and access areas.

Paper 203, Page 1655-1662

Insulating Block for Elimination of Thermal Bridge

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Abstract: The increasing quantity of waste materials is associated with continuously increasing need for their recycling and reuse. An important subgroup of waste materials is polymers. Selected polymers with suitable thermal and mechanical properties can be used with advantage also in civil engineering. Application of recycled polymers suitably supports decreasing of energy exigency and thus the area of sustainable development. Current trend of energy savings in civil engineering is the proposal and construction of low-energy and passive houses. This new concept is associated with the arisen need to solve originated details both in terms of the design and material. One of the details that is described in the article and solved via the new product made of waste material is a wall footing detail.

Paper 204, Page 1663-1671

Polymer Window Subframe for Passive Houses

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Abstract: The increasing quantity of waste materials is associated with continuously increasing need for their recycling and reuse. An important subgroup of waste materials is polymers. Selected polymers with suitable thermal-technical and physical-mechanical properties can be used with advantage also in civil engineering. Application of recycled polymers suitably supports decreasing of energy exigency and thus the area of sustainable engineering.

One of current trends of energy savings in civil engineering is the proposal and construction of low-energy and passive houses. This new concept is associated with the arisen need to solve originated details both in terms of the design and material. On the basis of analyses details of critical areas were outlined. In the place of discovered imperfections design solution with proposal of products made of recycles eliminating the imperfections of the design was designed. The issues are processed within the research intent labelled "Progressive construction materials using secondary raw materials and their influence on the life span of the civil engineering structures", which is now being solved at the Faculty of Civil Engineering of the Technical University in Brno, Czech Republic.

Paper 205, Page 1672-1679

The Application of Recycling Material for the Sustainability of Slopes: A Case Study of Two Sites in Hong Kong

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Abstract: Recycling materials are being increasingly used to prevent the growth of waste materials; to reduce the consumption of raw materials; to save energy as well as to reduce greenhouse emissions. In Hong Kong, the construction industry generates about 11 million tonnes of demolition waste each year which amounts to about 4 times as much as of municipal solid waste. This construction waste could produce about 2.3 million tonne of recycling waste annually. Recycling of waste material can be considered as the key concept of modern waste management and is classified as the third component of waste hierarchy to relieve the waste pressure on the society. In Hong Kong, both waste management and ecological rehabilitation of man-made slopes are major concerns in the society. The objective of this paper is to appraise the merits of applying recycling material such as Hydro Mulching and to analyze the scope and various possible applications of recycled materials for slope stability. The major constraints of this innovative idea of applying hydro-mulching for the restoration of the ecological rehabilitation of the slope are discussed and integrated merits of this approach are provided.

Paper 206, Page 1680-1685

An Evaluation of the Priority Order in Applying the Sustainable Office Building Design Focused On Ubiquitous Space

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Abstract: Recently, on account of increasing interest of sustainability, needs for sustainable building is growing more and more interested in construction industry. According to these concerns, it was introduced and in operation related systems, such as 'indoor air quality control', 'housing performance indicator system' and 'green building certification system' in Korea. Although practical affairs and researches are in progress to apply sustainable design in office buildings, there are still a lot of environmental criteria which could not be easily quantified in design phase and no information about the application priority order in office building design. Therefore, this research focuses on definition and quantifying the environmental criteria (factor) and finding application technology priority order in design phase for sustainable office building. To meet the needs of the research, firstly relatively representative sustainable design criteria were identified and prioritize the identified factors and ranking the importance level of each factor through a survey of the experts and office building architects.

Paper 207, Page 1686-1692

Causes and Minimization Techniques of Materials Waste in Nigerian Construction Process

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Abstract: A major characteristic of average construction sites in Nigeria is the presence waste materials in various forms and large quantities. This culminates to *inter alia*, high construction costs and great hindrance to affordability of good houses to the citizens. In this regard, a survey research was embarked on; it focuses on identifying the causes of materials waste incidence and their various minimization techniques in Nigerian construction

process. The population of the study is the construction professionals in selected firms in Nigeria. It involves the usage of a designed questionnaire administered via convenience sampling technique. Certain predetermined causes coined from literatures are included in the questionnaire while open-ended questions are employed to elicit the actual materials waste minimization techniques in the firms. Descriptive statistics tools are used to analyze the data. The study reveals causes of materials waste as: uneconomical shape of materials and components due to design; building failure/defects; workers' mistakes; theft; vandalism; inconclusive specifications; estimators' errors; ineffective communication; unfamiliarity with alternative products; design changes; lack of proper supervision; loading and unloading of materials; various forms of materials' packaging; substandard materials; poor site layout; misinterpretation of drawings; poor site conditions; setting out errors; and improper transportation of materials. It also sheds light on the materials waste minimization techniques as: materials inspections on arrival on sites; documentations of materials in and outflows; adherence to design details; effective communications; good transportation systems for materials; good storage facilities; training of storekeepers/site personnel; reuse of materials; daily stock taking; usage of materials requisition booklets; ensuring sub-soil investigations before projects commence; and regular site meetings. Conclusions are made based on these findings in the study. However, the study recommends that practitioners should employ all the techniques discovered in the study to minimize materials waste in their projects. This study will therefore contribute to materials waste minimization both in Nigerian and global construction processes.

Paper 208, Page 1693-1700

Sustainable Technology of Conservation of Wall Copings of Architectural Heritage Torso

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Abstract: Selection of appropriate methods of conservation of historical masonry constructions, made originally of stone, or brick materials opens a lot of questions, which have to be solved both from

technical as also methodic point of view on the problem. Important decisions have to be made in conservation process of ruins of old castles, where several binders like lime, cement, resin etc. can be used - with different results. The paper deals with the results of a research, which is oriented towards the use of various building conservation technologies (techniques and procedures) for wall copings at architectural torso in Central Europe. It was undertaken by the Slovak University of Technology – the Faculty of Civil Engineering – Architectural Heritage Conservation Centre (with further partners). The output of mentioned research was is evaluation of each of the reviewed techniques, used in its original conditions – at each of the building in its specific environment. The best conservation solution – especially from technical point of view – can be achieved by slowing of dilapidation process by combining of various techniques. This means not only conservation of constructions, but also their partial reconstruction, modernisation, revitalisation, including the assuring of partial use of the building, or its guarding and realisation of regular qualified maintenance, by repeating of technical conservational activities in some time intervals. The paper is supported by a couple of case studies and documentation of concrete situations, recorded during the research on several locations of ruined castles in Central Europe.

Paper 209, Page 1701-1708

A Review of International Green Building Certification Methods: A Roadmap for a Certification System in Turkey

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Abstract: Stakeholders in the construction industry are demonstrating their commitment to solve environmental problems by building in a more environmentally friendly way through using environmental standards for their buildings. The construction sector's sense of social responsibility is

also generating a demand for certification systems to measure the environmental performance of buildings. This paper summarizes the approach used by some of these rating methods, demonstrates a comparative approach between these rating systems, and discusses the minimum conditions available in Turkey that will enable the effective use of these standards. The authors aim to provoke a discussion about whether Turkey needs its own green building accreditation system. They suggest developing a system which better aligns with sustainability principles and free flows of information based on the lessons learnt from other certification systems.

Paper 210, Page 1709-1717

Why Sustainable Building Design and Construction? : Why Now?

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Abstract: Even though the movement toward sustainable design has made obvious strides in recent years, many of today's buildings, construction practices, and land-use patterns are still not sustainable. Modern architecture continues to produce uneconomic and uncomfortable homes which can be inhabited only with the aid of the most expensive devices for heating and refrigeration contributing to health problems, ecological degradation, economic disadvantage, and social injustice.

It is a well-known fact, that constructing and operating buildings, not only requires enormous amounts of energy, water, and materials; but also that it produces large amounts of waste. And depending on where and how they are built, buildings affect the ecosystems of the surrounding region. Furthermore, buildings create new indoor environments that present even more environmental problems and challenges to current and future generations.

Globalization has captivated and heightened our awareness on the importance of ecological integrity and diversity. Earth-friendly, sustainable building design and construction practices are no longer a mere fad, but have become an urgent necessity.

Sustainable development requires a multi-dimensional way of thinking and collaboration among educators, practitioners, and industry partners. This paper will discuss the need for trans-disciplinary cooperation and will propose a strategy for interdisciplinary education in sustainable building practices aimed at future designers, constructors, and members of the society at large.

Paper 211, Page 1718-1726

Clean, Green and Sustainable Building Elements: Masonry and Brick

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Abstract: Masonry and brick have a long history of successful use because of their design flexibility, durability, low maintenance, as well as variety of colors, shapes, textures, and sizes. Moreover, an unsurpassed life cycle, exceptional energy efficiency, natural ingredients, minimal waste, and countless recycling options are just a few of the properties that make masonry and brick superb green sustainable materials for sustainable building design. This discussion will focus on the natural fit between sustainable design and masonry.

The U.S. Green Building Council defines sustainable design: as the practices of design and construction that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in six broad categories: sustainable site planning, safeguard water and water efficiency, energy efficiency and renewable energy, conservation of materials and resources, indoor environmental quality, and innovation and design process. In addition to describing masonry and brick as a clean, green, and sustainable building material, the research here highlights the Leadership in Energy and Environmental Design (LEED) Green Building Rating System and the role of masonry in LEED construction.

Paper 212, Page 1727-1734

Building Green with Concrete

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Abstract: The environmental movement toward sustainability has motivated innovative companies, researchers and industry coalitions to be more environmentally responsible and seek ways to minimize the negative environmental impacts of concrete production and find ways concrete helps building green. Although concrete has a lower total energy intensity than other generally used construction materials, cement production is a highly energy-intensive process and entails potentially significant air and water pollution. In addition, the natural aggregates have finite sources and many public concerns over environmental issues oppose the production of sand and gravel by dredging huge cavities in the traditional landscape. This article highlights several approaches to promote concrete's role in environmental friendly construction and its contribution to sustainable development. This includes use of pozzolanic materials as a replacement of Portland cement in concrete, substitution of virgin aggregate by recycled concrete aggregate, reducing embodied energy and carbon dioxide (CO₂) emission of cement production, use of pervious concrete in storm water management, reducing heat island effect, enhancing energy performance of buildings, use of concrete for CO₂ absorption, and reusable and deconstructible concrete buildings.

Paper 213, Page 1735-1742

Indoor Air Quality Optimization to Increase Worker Productivity in Commercial Buildings

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Abstract: Sustainable design, construction, and operation practices have been developing rapidly. One of the criteria of building a more sustainable environment is to create a healthy and comfortable indoor air quality (IAQ). Specific levels of indoor air pollutants may affect the health, comfort, and the productivity of the occupants of a building. Many private and public entities have realized the importance of space optimization in order to increase the productivity of their employees. However, experts lack a quantitative decision

making methodology to balance the trade offs between increased IAQ and worker productivity. The building industry and its clients lack the resources to identify optimum solutions for a sound commercial solution. This study introduces a decision model of linear mathematical programming for optimizing costs associated with IAQ and worker productivity in commercial buildings. This study utilizes a set of decision variables, technical, and legal constraints, as well as a sample objective function to achieve the maximum financial benefits of a better IAQ, for commercial buildings. The results of this optimization model determines the levels of outdoor and filtered air inside a commercial building by considering cost of increased or decreased worker productivity as well as other building and business specific data.

Paper 214, Page 1743-1748

Improving Management of Solid Waste in Buildings

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Abstract: This paper discusses the feasibility of using newspaper discharged in the municipal solid waste (MSW) stream as biomass to produce ethanol. A production yield established in the literature indicates that 1 ton of newspaper has enough cellulose to produce 401 liters of ethanol through the enzymatic hydrolysis process. All paper found in the trash stream of a municipality has a potential to produce 9,452,158 million gallons of ethanol/year. The green building credits to handle construction waste and recyclables in an occupied building are discussed and results of real cases presented, the most recent data composition of the recyclables material found in the MSW is also presented, and suggestions are offered to design facilities in new buildings that will facilitate recycling to its occupants, a construction of a pilot plant to convert newspaper into ethanol is proposed to operate in a university campus environment the commercialization of the process.

**A Review of Green Building Movement
Timelines in Developed and Developing
Countries to Build an International
Adoption Framework**

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Abstract: The need for sustainable development in the construction sector has become significant in the last decade mostly due to the major resource consumption and contamination buildings generate. Green buildings have the potential to minimize this negative impact on the environment and offer business and occupant health related benefits. Many countries have either already adopted the green building guidelines or are in the process of adopting them. Developing countries are experiencing exponential growth in the built environment and there is a great potential of making the design and construction practices in these countries more sustainable through green building guidelines. Rapid adoption of these guidelines is important yet challenging. Acceptance of the green building guidelines in various societies can be attributed to comparatively a long history of this movement. The overlaps, similarities and differences in timelines of green building movement in various countries can help generate the first step on building a framework of green building movement and assessment systems adoption in the international arena. With this motivation, this paper presents the background of green building movement in the selected developed and developing countries: United States, India, and Turkey. The paper addresses emerging green building movement in these countries' markets based on the historical review and points out future directions of research.