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Construction Personnel in Practice

This first chapter introduces the background and objectives of the book. It also discusses the characteristics of the construction industry; the nature, functions and interrelationships of various construction organisations, projects and personnel from an international perspective; the contribution of various member throughout the construction life cycle; and the potential for these industrial, organisational, project and individual characteristics, as well as construction-related work tasks, to cause stress for construction personnel. Along with the discussion of stress management in construction in the chapters which follow, several studies of construction personnel from various nations will be discussed here in order to present an overview of the current environment, results and trends in stress management research in the construction industry context. This chapter provides background information to contextualise the discussion in the remainder of the book.

1.1 Background to Stress Management in Construction

The construction industry can be characterised as *competitive, dynamic and challenging*. A construction project is a unique human endeavour which combines the different goals and objectives of multiple stakeholders. They need to deploy various resources to tackle change and uncertainties and complete the work within a limited time and specific scope (Turner 1993). Normally, construction personnel working in different organisations (such as clients, government departments, consultancy companies, contractors, sub-contractors and suppliers) need to work together to ensure the success of a project. Communication and cooperation between stakeholders is critical for

construction personnel, since this is directly related to their efficiency and the success of the project. However, due to the fragmented and dynamic nature of the construction sector (The Chartered Institute of Building [CIOB] 2002), communication between stakeholders is often limited, causing difficulties in cooperation and resulting in a negative impact on outcomes (Hewage, Gannoruwa and Ruwanpura 2011). Moreover, construction personnel often work in crisis-ridden site environments at high risk of injury. Hence, it is not surprising that the majority of personnel, including architects, project managers, engineers, surveyors and construction workers, report feelings of *stress* in their daily working lives (Leung, Chan and Yuen 2010). According to a recent study of occupational stress in the construction industry (CIOB 2006), almost 70% of personnel suffer from stress, anxiety or depression.

The level of stress experienced by construction personnel largely depends on the source of stress, or more specifically the *stressors*. Stress occurs when an individual encounters a misfit between his/her actual ability and the environment (such as work and home) (French, Rogers and Cobb 1974), which may induce both emotional and physical symptoms (Moorhead and Griffin 1995). Common stressors found in the construction industry include long working hours, tight project schedules, limited organisational support and safety issues (Goldenhar, Williams and Swanson 2003; Leung et al. 2005a). These stressors and the stress reactions they create, are likely to induce physical and mental fatigue, undermine team performance, reduce working abilities and ultimately lead to the potential breakdown of the whole project (Ng, Skitmore and Leung 1995; Sutherland and Davidson 1989).

Stress can have serious implications not only for health and task performance, but also profitability and organisational development (Cooper and Dewe 2008). In terms of health, stress is known to be related to heart disease, negative emotions and extreme physiological symptoms (Cooper 2001). The British Heart Foundation suggests that coronary heart disease, which is often attributable to stress, costs £200 per employee per year in the UK (Hibbert 2003). According to the Health and Safety Executive (2007), 10.5 million working days are lost due to stress-related illnesses in the UK every year. The cost implication of occupational stress for employers is \$381 million per annum (Cousins et al. 2004). Moreover, individuals in stressful situations tend to make rigid, simplistic and superficial decisions (Cherrington 1994), leading to the failure of construction projects to meet time, quality and budget requirements. In fact, highly stressed workers change jobs more frequently than those who are under less pressure, so excessive stress may also have a serious effect on the turnover intention of construction personnel (Djebarni 1996).

However, it seems that most construction employers focus mainly on profit while ignoring the importance of the health of their employees. This has a direct influence on project and organisational outcomes. Employees are the most valuable asset of all construction companies (Rowley and Jackson 2011). Ignorance of the effects of stress on their health not only costs companies a lot of money, but can also lead to lawsuits. For example, French, a UK police officer and his colleagues sued their employer, the Chief Constable, for negligently failing to provide proper training resulting in psychiatric injury (e.g. All England Reporter 2006). Employers have a legal responsibility to provide a healthy and safe working environment for their employees.

However, stress is not necessarily always harmful. When talking about stress, people generally mean “overstress” (too much) and its effects. Though overstress can result in burnout, too little stress (understress) can also affect the performance of construction personnel through the phenomenon termed “rustout” (Lingard 2003). Studies suggest that there is an inverted U-shaped relationship between the degree of stress and level of performance (Leung et al. 2005b; Yerkes and Dodson 1908). To optimise performance, an individual needs to be able to react and cope with his/her stress. There are various coping approaches, from which three main sets of behaviours have been identified: (i) problem-based coping, which focuses on task situations or problem solving (Carver, Scheier and Wein 1989; Weatherley and Irit 1996); (ii) emotion-based coping, which deals with emotional or anxiety reactions (Haynes and Love 2004; Lazarus and Folkman 1984); and (iii) meaning-based coping, which focuses on the attitudes resulting in positive emotions and reenacting the adoption of problem- or emotion-focused coping (Kabat-Zinn et al. 1992). However, not all types of coping strategy are adaptive. Studies in this area tend to categorise problem- and meaning-based coping as adaptive (see e.g. Folkman 2010; Leung, Liu and Wong 2006) and emotion-based coping as maladaptive (Dyson and Renk 2006). Maladaptive coping is not uncommon among construction personnel (Haynes and Love 2004; Leung, Liu and Wong 2006).

In fact, numerous researchers have investigated the stress experienced by different types of professionals such as nurses (Dailey, Ickinger and Coe 1986), teachers (Baruch-Feldman et al. 2002) and general managers (Davidson and Cooper 1983). Stress is also increasingly considered as a major problem for the construction industry in many countries such as Australia, South Africa, the UK and the US (Bowen, Edwards and Lingard 2013; Djebarni 1996; Lingard 2004; Loosemore and Waters 2004). However, little comprehensive investigation into stress management methods for construction personnel has so far been conducted, leading to an information gap. There is clearly a need for a comprehensive research study of effective stress management techniques for construction personnel working in industry.

1.2 Construction Organisations

In the modern industrialised and commercialised world, various organisations are involved in the construction industry, including governments, developers, consultants, contractors, subcontractors, and suppliers.

1.2.1 Governments

In order to keep the construction sector in good order, governments in all countries exert a great deal of influence over various activities. There are generally two types of government structure, namely centralised and decentralised. Each affects the construction industry in their country in different ways.

Centralised government refers to a situation where the government makes all the important decisions affecting the nation or state and handles the associated responsibilities. This type of government can directly or indirectly influence the construction industry by applying a large amount of regulations and policies in the areas of planning, financing, construction and maintenance, with a powerful and immediate effect (Wells 1986). The government can directly enact the industrial regulations and codes which construction personnel must observe. Any violation of the code will attract severe punishment in terms of fines and removal of qualifications for example. In addition, centralised governments can also indirectly affect the construction industry via various policies. For instance, China has a centralised government with a comparatively strong top-down mandate. The policy of opening up the construction market internationally, embarked on in 1992, has attracted various overseas competitors who have introduced new technologies to the Chinese construction market. Such a situation may be stressful for local personnel, who were educated in and have worked under the closed system for years, if they are expected to catch up with new technology and create competitive advantage in the new market environment. Hence, government policy can induce stress in construction personnel (Leung, Sham and Chan 2007).

A *decentralised government* spreads its responsibilities out to different bodies like provinces and states, so they are free to set their own construction laws and regulations and prevent local development from being circumscribed (Wallis and Oates 1998). For instance, in a decentralised national government, it is the local municipal or state government, not the central authority, that is responsible for setting and enforcing the safety, health and environmental standards for building and construction projects undertaken within a city or state. This may place a strain on developers and contractors, especially nonlocal organisations, by for example imposing compulsory regulations and site inspections. It is not easy for construction personnel, particularly those involved in international projects and/or working as expatriates, to understand the specific context of the industry in different states. Unfamiliarity with the building ordinances and regulations in different regions can also cause difficulties at work, once more leading to stress for construction personnel (see e.g. Leung and Chan 2012).

1.2.2 Developers

A developer is usually considered as the party who owns the land, develops it through construction and owns, operates and/or sells the property at the end of the project (Ashworth 2002). Developers hold an important position in the built environment, as they have the responsibility of delivering the enormous amount of real estate required for the growing urban population (Royal Institution of Chartered Surveyors [RICS] 2011). There are three types of developers, classified according to organisational size and capacity: large, medium and small (Anikeeff and Sriram 2008; Psilander 2007). Generally, small and medium developers have fewer

resources and capacity to manage risk than the larger ones, which are capable enough to maintain every project in line with governmental regulations. Hence, the former types are more easily affected by changes in government policy or dynamic market situations, such as an increase in inflation leading to project overbudget. Large developers may have sufficient financial and professional support, either inside or outside organisational boundaries. They normally carry out large-scale, complicated projects which involve higher levels of uncertainty and risks from factors such as the economic crisis, government policy and site constraints. Even small changes may significantly affect their profit and overall business strategy. Therefore, different sizes of developers inevitably face different types and levels of stress.

Developers can also be classified into private and (semi-)public (Barrie and Paulson 1992). *Private developers* work on construction projects for private individuals or groups, while *(semi-)public developers* are government-related organisations developing such as hospitals, colleges, schools, libraries and churches, etc. Normally, private developers aim for profit. A developer has to control the project finances closely in terms of various aspects including land cost, design, construction and marketing, in order to ensure business survival. All projects must follow the regulations and obligations created by government. However, government economic policy, housing problems and environmental issues can easily affect operational strategy and profits, thereby inducing stress to project members. Meanwhile, although (semi-)public developers are less susceptible to stress from economic and political changes, they are also responsible for providing appropriate and adequate facilities to satisfy the diverse needs of the public. Such demands are especially challenging in democratic countries, where citizens have more freedom of speech and are more likely to raise complaints and criticisms towards the government.

1.2.3 Consultants

The term consultant usually refers to a professional or a firm in a specific field with a specific knowledge of a particular subject matter and influence over an individual, group or organisation (Block 1999). Various consultants work in the design and management of construction projects, such as planners, architects, structural engineers, civil engineers, building services engineers, quantity surveyors, financial advisors, lawyers, project managers, “green” building consultants and landscape engineers. They tend to have the best-in-class expertise to advise developers and contractors on a diverse range of built environment issues (RICS 2011). Each consultant offers particular management services to ensure that projects can be delivered successfully (Kirmani and Baum 1992). Although consultants normally have less direct power to make major changes to projects in terms of design, programming and cost (New York State Department of Transportation [NYSDOT] 2003; Tordoir 1995; Waters 2004), failure to select appropriate personnel can lead to unsatisfactory project performance during the design, construction, completion or operations stages (Nitithamyong and Tan 2007).

Consultants play essential roles in the different stages of a construction project, from inception to post-construction. In practice, consultants (such as architects and civil engineers) can offer feasibility research services in the predesign stage; prepare drawings, specifications and cost plans in the design phase; advise on selecting the best contractor in the tendering stage; and manage and control quality, cost and programming in the construction phase (Chow and Ng 2010; Smith and Jaggar 2007; Stein and Hiss 2003). In addition, conflict is inevitable in the construction process, creating stress for consultants such as quantity surveyors (Leung, Skitmore and Chan 2007) given that they tend to play an essential gatekeeping role in protecting developers or contractors from the various claims made by other parties. In the post-construction stage, consultants need to carry out inspections in order to ensure the quality of the final products, because they have a professional responsibility to ensure the building satisfies the requirements of the project owner and complies with regulations (RICS 2011). In other words, the work scope of consultants covers every stage of the construction process. However, since they tend to be located low in the project hierarchy with limited direct power, they often face excessive or conflicting demands which increase their workload and extend their working hours, resulting in stress (Leung et al., 2005a, 2008).

1.2.4 Contractors

Builders are usually regarded as *contractors* who deliver a construction product for a specified cost at a particular time (Hans 1984). In general, contractors can be divided into two types, namely main and subcontractors. *Main contractors* participate in a process of transforming inputs (labour, materials, equipment and capital) into outputs (construction products) (Winch 2010). At the preconstruction stage, they will have to compete against each other to win the contract. Price and other factors, including experience, reputation (such as safety record) and professional qualifications, are considered critical selection criteria. Main contractors often put themselves in fierce competition so as not to lose out on market opportunities. During the construction process, main contractors need to carefully plan and manage all the necessary resources for erecting a building (such as the construction phases, sequences, programming and budgeting), which involves an immense amount of work. Inappropriate management can lead to the failure of construction projects as a result of problems such as exceeding cost limits, poor-quality buildings, safety incidents and delays (Clough and Sears 1991). Moreover, there are lots of stakeholders involved in a construction project, such as the client, planners, project managers, architects, engineers, surveyors, suppliers, specialists and end users (Chinyio and Akintoye 2008). Main contractors have to liaise with, coordinate and manage all these parties so as to ensure successful delivery. Hence, given this heavy responsibility and workload, the staff of main contractor firms can easily suffer from stress (Djebarni 1996; Leung, Chan and Dongyu 2011).

A *subcontractor* denotes a construction firm that is responsible for undertaking part of the work on behalf of the main contractor (Errasti et al. 2007). In general, there are two types of subcontractor in the construction industry: (i) domestic subcontractors, who are selected and employed directly by main contractors in a private arrangement and have no contractual relationship with the client; and (ii) nominated subcontractors, who tender to and are then appointed and employed by the architect or client. In the latter situation, the main contractor will be instructed by the client to enter into a contract with the nominated subcontractor (RICS 2011). Domestic subcontractors are often considered to be effectively part of the human resources of the main contractor. They have comparatively less protection from the client and cannot enjoy the benefit of the fluctuation clause in the contract between the main contractor and client, inducing financial pressure and the stress associated with this. On the other hand, nominated subcontractors also face difficulties such as disputes over the release of retention monies and mutual interference with the main contractor in the construction process. In addition, main contractors may realise the greatest cost savings by withholding from subcontractors, increasing the prevalence of unfair practices (Kennedy, Morrison and Milne 1997). Hence, nominated subcontractors are also in a stressful situation.

1.2.5 Suppliers

For the delivery of construction products, a supply chain should be established in which resources, including labour, materials and equipment, are organised and utilised (Winch 2001). Suppliers can be classified into two main groups: materials and equipment. Both play a major role in a construction project, as the condition and quality of materials and equipment significantly affect success. *Materials suppliers* usually supply the raw materials for the delivery of construction projects and also assist the main contractor in inspecting quantity and quality. On the other hand, equipment, such as compactors, excavators and tower cranes, is also necessary for construction projects. This is provided by *equipment suppliers* (Day and Benjamin 1991). To ensure the requirements and contractual specifications are met, equipment suppliers usually provide onsite installation and regular inspections and sometimes also carry out onsite maintenance.

To achieve project outcomes successfully, it is necessary to select proper suppliers of both materials and equipment. In the public sector, completeness and fairness are considered to be important. Hence, all potential suppliers are identified and given equal opportunity to tender for the work. Various rules, norms, standards and legal requirements have to be reviewed, while a systematic assessment approach, such as a weighting scheme, is applied to regulate the process and enhance transparency, objectivity and nondiscrimination (Telgen and Schotanus 2010). In the private sector, profit maximisation is normally the main goal of developers and contractors (Wallace 2007). Selection of suppliers is therefore conducted only when there is a real need to identify the best. In most situations, suppliers compete in terms of various aspects such

as minimising material and production costs while simultaneously enhancing the quality of services and products. The final cost always fluctuates depending on the market (e.g., an increase in material prices may cause the supplier to lose all marginal costs). Furthermore, since most construction projects have a tight schedule, any delay in the delivery of supplies might cause severe problems for the project owner and other personnel. Hence, material and equipment supply is often in the critical path of the project, which makes it unavoidably stressful for those involved.

1.3 Construction Personnel

According to the outline plan of work issued by the Royal Institute of British Architects (2007), construction work involves four major stages: briefing, sketch plans, preparing working drawings, and site operations. The second and third of these are closely related to project design and can be collectively termed the *design stage*, while the site operations phase is also known as the *construction stage*. Construction personnel contribute their particular knowledge to each phase in order to ensure project success.

1.3.1 Project Managers

Project managers, working on behalf of the project owner, are responsible for getting the project completed in accordance with the schedule, budget and quality standards. They achieve this by organising, planning, scheduling and controlling the field work (Sears, Sears and Clough 2008). They act as the central communication point between the project owner, design team, contractors and other parties and engage in the various activities involved in construction projects from inception to completion. In the *briefing stage*, the project manager is responsible for feasibility studies, site visits and the employment of consultants (CIOB 2000). In the *design stage*, he/she needs to advise clients on selecting the procurement method, managing the design process and selecting contractors (Bennett 2003). During the *construction stage*, the project manager acts as an effective leader and is responsible for the implementation of the programme, arrangement of project finances, fulfilment of statutory requirements and so on (CIOB 2010). Moreover, managers also need to ensure that all construction work adheres to environmental protection ordinances and that all onsite staff are working in a safe environment with adequate protection from injury or accident.

As the leaders of construction projects, project managers are regarded as key personnel and their performance significantly affects the whole project. Their roles include not only planning, organising and supervising the project team and overseeing the progress of work, but also dealing with demanding time pressures, intrinsic uncertainties and multiple stakeholders (Leung, Chan and Dongyu 2011). Hence, they normally have an intensive workload over a lengthy period, since they are responsible for the project from the briefing to the construction stages. In addition to this heavy workload,

project managers also shoulder lots of responsibility, as every single decision they make has a direct impact on the scheduling, cost, quality and/or ultimate success of the project. Therefore, it is inevitable that they are subject to a great deal of stress. The decision making of individuals working in excessively stressful situations is generally more rigid, simplistic and superficial (Cherrington 1994). Excessive stress has been shown to have a negative impact on the performance of project managers in the construction industry, which in turn has a negative impact on outcomes (Leung, Chan and Olomolaiye 2008).

1.3.2 Architects

Architects are licensed professionals trained in all aspects of the art and science of building design (Bennett 2003; Jackson 2004). They can also act as the controllers of the construction process in order to ensure that the building is built as designed (Morton 2002). In the *briefing stage*, the architect carries out studies of site conditions and project issues and provides a professional opinion about project feasibility to the owner. Architects generally also provide solutions regarding building design. In the *design stage*, architects are mainly responsible for the preparation of detailed drawings and specifications and also participate in the tendering process (Chappell and Willis 2010; Ogunlana 1999). In addition, architects also need to communicate with other consultants in order to solve all architectural, legal, technical and financial problems arising; meet the client's requirements; and prepare a full scheme for statutory approval. They also need to supervise the actual *construction stage* by regularly inspecting the construction work and issuing instructions to ensure that it is being performed effectively. They also take responsibility for resolving disputes among various other parties (Mow 2006).

Playing such a wide range of project roles means architects face a heavy and challenging workload. Not only do they need to meet all the requirements of the project owner (e.g. function, value, cost), but they also need to ensure the design does not violate mandatory government building regulations and laws (such as town planning requirements, fire safety design requirements, height limitations) (Oyedele and Tham 2007). In addition, architects also need to deal with the complicated relationships among various parties in order to keep the focus of the entire project team on achieving its goals. Like project managers, an architectural professional plays a long-term and challenging role in a construction project, from inception to completion. Since building designs can be affected by numerous constraints discovered by various professionals at different stages (such as subsoil constraints detected by geotechnical consultants, difficulties in building services design in the limited space above the suspended ceilings as encountered by building services engineers and over-budgeting as estimated by quantity surveyors) architects are driven by various pressures to liaise and cooperate with different parties. They may also be required to revise their designs in different construction phases, which is a particularly stressful element of their role.

1.3.3 Engineers

Engineers are usually the lead designers for infrastructure and civil projects (Jackson 2004). They design materials, structures and systems in consideration of the project limitations, feasibility, safety and cost. *Civil engineers*, including structural, material and geotechnical and building services engineers (such as fire services, mechanical, lift and electrical engineers), are the major types found in the construction industry (Schwartz 1993). *Civil engineers* are responsible for designing suitable structures to support the load of construction products, such as bridges, tunnel dams and buildings. They usually need to visit the site to understand the natural environment in the *briefing stage*, so that they can design the most suitable structure (Behrens and Hawranek 1991; Ng and Chow 2004). Then, civil engineers will cooperate with other professionals to prepare drawings and specifications in the *design stage* (Lupton 2001). In the *construction stage*, they must assist other parties to resolve any technical problems and ensure the quality of construction products. As well as affecting the shape and layout of the construction project, the work of civil engineers directly determines the stability, reliability and safety of the structures being built, so any mistakes may cause significant losses in terms of money and human lives (Building Department 2010; Manik, Greenhouse and Yardley 2013). Such design work is difficult for civil engineers, especially on uncertain soil conditions, which undoubtedly causes them high levels of stress.

Building services engineers are responsible for the design, installation, operation and monitoring of the mechanical and electrical systems used in buildings (Chappell and Willis 2010; Muscroft 2005; Shoesmith 1996). Their work focuses mainly on the safe, comfortable and user-friendly operation of the final products. In practice, different types of building services engineers will work together in order to provide suitable facilities within a limited space. A well-planned, compact building services design not only enhances the quality of life of building occupiers, but can also leave more space for profit making (Shoesmith 1996). In the *briefing stage*, building services engineers investigate the microclimatic conditions of the proposed conceptual design and prepare preliminary building services design criteria. Based on these criteria and with a consideration of life-cycle costs, they then design the lighting, heating, air-conditioning and other systems in the *design stage*. In addition, they need to ensure the correct installation of the various systems in the *construction stage* and advise on maintenance requirements. They are also responsible for providing services which meet practical requirements and avoiding any violation of mandatory government regulations (such as those relating to fire safety and air ventilation). Any deviation may induce additional costs and/or time. In fact, since building services normally account for over 25% of total construction costs (Census and Statistics Department 2011), they are critical to the overall construction programme. Holding such a critical position, while at the same time being caught in the middle of the conflicting expectations of clients and architects and being subject to the requirements specified by building ordinances, building engineers can also suffer from significant stress.

1.3.4 Quantity Surveyors

Quantity surveyors are responsible for studying the economic and financial implications of a construction project and advising the project owner, the architect and engineers on matters relating to cost (Ashworth and Hogg 2002). All of their work aims to ensure that the resources of the construction industry are utilised to the best advantage of society (RICS 1976). The responsibilities of quantity surveyors include a variety of activities, from inception to completion. In the *briefing stage*, quantity surveyors appraise the local construction cost level, collect cost information from similar projects and so on, in order to advise the project owner on appropriate cost limits (Ferr, Brandon and Ferry 1999). Then, with the cooperation of other participants, they prepare a cost plan to guide the design work of architects and engineers, write tendering documentation to use when selecting contractors and undertake various other tasks in the *design stage* (Ferry, Brandon and Ferry 1999). During the *construction stage*, quantity surveyors prepare valuations for interim certificates, submit financial statements for variation and outstanding claims made by contractors and prepare the final accounts (Fryer, Fryer and Egbu 2004).

In practice, quantity surveyors are often pressed to produce accurate cost estimates within a rigid but short timeframe. The accuracy of their budgeting directly affects the outcome of the project and any over- or underestimates can be costly for the owner. This difficult task is often made even harder by a lack of cooperation between various project team members, such as project managers, main and subcontractors and suppliers, given that cost estimation relies heavily on the quality of the data associated with the production schedule, methods, materials, quantities and component costs. In such circumstances, it is not surprising to find that quantity surveyors are often under a considerable amount of stress (Leung, Chan and Olomolaiye 2008). On the other hand, their stress levels may escalate towards the end of a project, since they are responsible for signing off diverse variation orders and claims throughout the process from the beginning to the maintenance period.

1.3.5 Construction Workers

Construction workers are skilled and unskilled labourers who undertake a range of manual jobs. They are the front-line force of construction projects (Anwar 2004; Fung et al. 2005). Rather than being a single class of skilled and factory workers, construction workers engage in various trades such as excavation, concreting, brickworks, plastering, carpentry and pumping (Vocational Training Council and Building and Civil Engineering Training Board 2011). They have the most significant and direct impact on project outcomes in terms of time, cost, quality, safety and environmental impact (Applebaum 1999). Compared to other participants, construction workers mainly contribute physical work onsite. Due to the poor working environment and the physically demanding nature of their efforts, construction is a very high-risk environment for the individual worker. Construction workers

run a higher risk of injury than those in other industries through accidents such as falling from height, being hit by falling objects from above, being injured by equipment such as hoists and steel-cutting machines and suffering electric shocks. In fact, construction has long been recognised as one of the most dangerous occupations (Beswick et al. 2007), in terms of both its annual industrial accident (63%) and fatality (79%) rates. These are the highest of all industries in various cities and countries like the US (Mitropoulos and Memarian 2012), UK (Zhou, Fang and Wang 2008) and Hong Kong (Census and Statistics Department 2009).

In addition to their exposure to the risk of accidents, construction workers also suffer from high levels of stress. Their work frequently requires prolonged standing, bending, working, lifting and carrying heavy things in a confined area either inside or outside the structure. Moreover, construction workers are often positioned at the lowest level of an organisation and have limited power over their resources and goals. It can be very difficult for them to reflect their needs and negotiate their rewards at the organisational level (see e.g. Tabassi and Bakar 2009). All these factors can cause stress. It has been shown that construction workers have the third-highest stress levels of any occupation worldwide and suffer from 1.7 times more stress than personnel in other industries (International Labour Organization 1992). As a consequence, numerous working days and millions of dollars are lost every year due to the negative consequence of stress among construction workers (Health and Safety Executive 2007).

1.4 Construction Projects

1.4.1 Nature

A project is a series of interrelated activities undertaken to create a unique product, service or result within a specific timeframe and under certain constraints (PMI 2000). A construction project usually also has particular attributes such as a long life cycle, capital investment, a large number of activities and participants, close regulation by government and the need to manage the effect of the environment and weather on operations (CIOB 2010). There are many different kinds of construction projects (Bosch and Philips 2003), which can be grouped into two broad categories: building and infrastructure. A *building project* is a way to add small or large structures to real property and land, including residential, commercial, industrial and other types (Bennett 2003). Such projects normally involve the construction of many different items such as external and internal walls, floor, wall and roof finishes, doors, windows, ironmongery and sanitary fittings. The cost of building projects usually varies significantly based on various factors such as the market situation, project locations, materials and the requirements of the project owner (Clough and Sears 1991; Martin 2004). Most are undertaken for the purpose of profit, so cost control may be overemphasised. The plethora of techniques which may be applied to control cost and maximise profits can increase the workload of various participants and place them under stress.

Infrastructure projects are those which build up the infrastructure of a country, including highway, tunnels, bridges, dams, restraining walls, drainage, slop surfaces, airports, harbours, waterways, dikes and retention ponds and pipelines (Bosch and Philips 2003; Plunkett 2007). Their development often requires multiple factors to be considered in terms of their design, financial, legal and social aspects. Normally, they are not undertaken for profit, but in the public interest. Budgets must be approved via a series of formal governmental steps. Mega infrastructure buildings demand sophisticated building techniques (such as geotechnical works for uncertain tunnels and slop projects, aerial technology for terminal buildings, runways and aircraft parking areas in airport projects). Furthermore, some construction projects (e.g. those involving highways, tunnels, airports and water supplies) are located in areas such as mountains and deserts which are far away from towns and cities, leading to a particularly tough working environment for those involved.

1.4.2 Construction Procurement

Procurement is the process used to deliver construction projects (Ashworth and Hogg 2002). Project procurement in the construction industry involves a systematic process of identifying and obtaining, through purchase or acquisition, the necessary project services, goods, or results from the outside vendors who will carry out the work. The selection of appropriate procurement methods is therefore essential as it determines the framework for project management, as well as the timetable, quality control and cost plans. All of those elements directly influence the duties of construction personnel and the risks they face and exert a degree of pressure and stress in the work environment.

Various methods of procurement are used in the construction industry, such as traditional, design and build, construction management, management contracting, build–operate–transfer (BOT) and build–own–operate–transfer (BOOT) (Cook and Williams 2004). Each method has advantages and disadvantages for the different parties involved. There is no single approach which always outperforms others in all situations, because each method brings a different degree of uncertainty and risk to each project. Adopting traditional procurement methods, for instance, involves various personnel in a specific sequence in which the project manager, architect, engineers and quantity surveyor will be employed to produce tender documents for use in selecting the contractor. Although this method affords the project owner a high level of cost certainty for a relatively low tender price (Ashworth and Hogg 2002), it may impose time pressures and hinder synergy arising from cooperation between different parties at the design stage, stifling innovation. In fact, lack of participation by the contractor in the design process may lead to low constructability of design, leading to further problems such as scope variations, conflict and disputes of various types. This is a further potential source of stress for those involved.

As an alternative to the traditional procurement method, *design and build*, which has now become one of the most popular approaches, is widely used in the construction industry (Quatman 2000). This arrangement transfers maximum risk to the contractor and shortens the overall project timescale, as the contractor takes full responsibility for the project involving both design and construction tasks. In line with having less responsibility and risk, however, the project owner may also have less opportunity to participate in the design stage and less power to control the design. This may lead to conflict and reduce the quality of outputs. In order to monitor project performance, project owners often hire an architect and quantity surveyor to provide essential independent advice and assess contractors' proposals. This directly affects progress and even overall cost as priced by the contractor. All parties may come under pressure from their own organisations, inevitably leading to stress.

1.5 Stress in the Construction Industry

Construction projects normally involve multiple stakeholders, long time-scales and substantial investment. Delivery consists of various complicated tasks. Every project is unique and dynamic and there are always unexpected problems (Langan-Fox and Cooper 2011). Construction personnel need to work with different team members across various projects at different stages. They can easily face **stress** during the implementation period and experience physical and mental stress symptoms such as depression, anxiety and poor physical health (Leung, Skitmore and Chan, 2007). Stress is prevalent in the construction industry. In a CIOB survey (2006), almost 70% of respondents admitted that they suffered from stress and more than half felt the construction industry had become more stressful. Moreover, the findings of existing studies may not fully reflect the real situation. Due to the impact of a popular 'macho' culture, construction personnel may not perceive stress as a problem (Gunning and Keaveney 1998) or may intentionally conceal their stress levels because they do not want to be regarded as weak (Health and Safety Executive 2007).

Studies show that cost, time and other people are the primary sources of stress for construction personnel (Sommerville and Langford 1994). For instance, dealing with changes to projects requires high-quality team performance (Loosemore and Waters 2004) and results in increased pressure to complete the project on time. Long working hours also cause high levels of stress (Lingard 2004) and the poor physical working environment in the construction industry also affects all participants and causes safety problems (Goldenhar, Williams and Swanson 2003). Moreover, being forced to finish complicated projects on time to the required quality and cost standards, as well as meeting the other subjective and objective requirements of the job, can be another source of stress (Haynes and Love 2004). In order to complete their work, construction personnel are assembled in teams in which they must cooperate and where their actions affect one another. Developing trust, collaboration, respect and conflict management are the

responsibility of all team members (Adams and Galanes 2003) and the need to address these issues has been linked to work-related stress and the psychological and physical health of construction personnel (Cotton and Hart 2003).

More and more attention has been paid over the last 10 years to studying work-related stress in the worldwide construction industry, with studies having been conducted in South Africa (Bowen, Edwards and Lingard 2013), the UK (Goldenhar, Williams and Swanson 2003), Australia (Haynes and Love 2004), the Netherlands (Janssen, Bakker and de Jong 2001), Hong Kong (Leung, Wong and Oloke, 2003; Leung, Liu and Wong 2006; Leung, Chan and Yu 2012) and the US (Loosemore and Waters 2004). Summarising the results of these studies (see Table 1.1) not only helps us to begin developing an integrated stress management model (Stressors–Stress–Coping Behaviour–Performance) which will benefit both construction personnel and academics working in related fields, but also serves as a platform for identifying and directing future trends in stress management research in the construction sector.

To develop a conceptual model for stress management in the construction industry, a systematic review has been conducted to summarise the outcomes of the various relevant research studies based on a coherent plan and search strategy. Studies were selected by identifying keywords such as ‘stressors’, ‘stress’, ‘coping’, ‘performance/outcome’, and/or ‘construction’ in the title, abstract and/or keywords of papers. To ensure quality, only papers listed in PsychINFO, Scopus and the Social Science Citation Index were included. A total of 45 papers investigating stress among different construction personnel such as project managers, architects, engineers, quantity surveyors and construction workers worldwide were included in the review. As shown in Table 1.1, this includes seven papers focused on the targets of project managers (one in South Africa, one in Australia, two in Hong Kong and three in the UK); nine studies investigating construction workers (one in Spain, one in Australia, two in the Netherlands, two in the UK and three in Hong Kong); and 29 papers investigating construction professionals in general (one in the US, two in the UK, three in South Africa, five in Australia and 18 in Hong Kong). Moreover, a further survey conducted by the CIOB covered a broad range of construction personnel from onsite workers to professionals.

Studies to date have tended to describe the degree and types of stress experienced by construction personnel working in industry. Construction personnel often suffer from anxiety and depression (Haynes and Love 2004; Sutherland and Davidson 1993) or even burnout (Janssen, Bakker and de Jong 2001; Leung, Skitmore and Chan 2007; Lingard 2004; Yip and Rowlinson 2009a, 2009b). Apart from the mental and psychological strain involved, construction personnel can also suffer from physical problems (Goldenhar et al. 1998; Goldenhar, Williams and Swanson 2003; Leung, Chan and Olomolaiye 2008). Out of the 45 papers studied here, nine classify the different dimensions of stress, including objective and job-related, subjective and emotional and physical (Leung et al. 2008; Leung, Chan and Yu 2009; Leung, Chan and Yu 2012).

Table 1.1 Systematic literature review of stress management studies in the construction industry setting.

Source	Location	Sample	Variables	Findings
Sutherland and Davidson 1989	England	36 male middle and senior construction site managers	Stressors (communication problems, work overload, conflict, work-home conflict) Mental health Anxiety Job satisfaction	1. Job satisfaction levels of construction site managers were not as high as for comparable managerial groups and most dissatisfaction was related to employee relations issues 2. Mental well-being for construction site managers was lower than for other population groups 3. Social support from a spouse or partner → anxiety (–), depression (–) and mental well-being (+) 1. Job satisfaction levels were low compared to a normative population and influenced by grade level 2. Mental health was affected by both grade of management and type of contract 3. Anxiety levels were significantly high, independent of managerial grade 4. Overload and role insecurity (fear of failure) → mental health (–) and high anxiety (+) 5. Organisational culture and climate → job dissatisfaction (+). 1. Job stress → performance (inverted U-shape) 2. Boss stress → performance (–) 3. Environment-job stress → performance (–)
Sutherland and Davidson 1993	England	Questionnaire: 561 construction site managers; Interview: 36 male middle and senior construction site managers	Task, personal, organisational stressors Mental health Anxiety Job satisfaction	1. Responsibility for others' safety and support from supervisors and male coworkers → job satisfaction (+) 2. Increased responsibility, skill utilization, harassment and gender-based discrimination and overcompensation → psychological symptoms of stress (+) 3. Overcompensation and job certainty → insomnia (+) 4. Harassment and discrimination → nausea and headaches (+)
Djebarni 1996	Algeria	71 site managers	Stress (boss, job and environment-job) Performance (leadership and project effectiveness) Job/task demands (job demands responsibility for safety of others, overcompensation, control) Organisational factors (harassment and discrimination, job certainty, availability of training, safety climate, skill utilisation)	
Goldenhar et al. 1998	England	211 female construction workers		

Janssen, Bakker and de Jong 2001	Netherlands	210 construction workers	Physical conditions (physical and chemical exposure) Moderator (social support from supervisor and male coworkers) Psychological symptoms of stress (affect: tense, sad, angry) Physiological symptoms of stress (headache, insomnia, nausea) Job satisfaction Illness (hypertension) Injuries (preventable events and near misses) Job demand, job control, social support Burnout	<ol style="list-style-type: none"> 1. Lack of social support → burnout and health complaints among construction workers (+) 2. A significant three-way interaction effect partly confirmed the synergism hypothesis: physical demands were only related to burnout if participants had poor job control and reported high social support <ol style="list-style-type: none"> 1. Job demands, training, responsibility for the safety of others and safety compliance → injury, near misses (–) 2. Job control, job certainty, safety climate, skill underutilisation, exposure hours → injury, near misses (+) 3. Harassment /discrimination, job demand, job certainty, safety compliance → physical symptoms → injury accidents (+) 4. Harassment /discrimination, job certainty, social support, skill underutilisation, safety responsibility, safety compliance → psychological strain → near misses (+)
Goldenhar, Williams and Swanson 2003	England	408 construction labourers (male and female)	Job stressors (job demands, job control, job certainty, overcompensating at work, training, safety climate, skill underutilisation, responsibility for the safety of others, safety compliance, exposure hours, harassment and discrimination and social support) Physical symptoms Psychological strain Injury Near-miss outcomes	<ol style="list-style-type: none"> 1. Job demands, training, responsibility for the safety of others and safety compliance → injury, near misses (–) 2. Job control, job certainty, safety climate, skill underutilisation, exposure hours → injury, near misses (+) 3. Harassment /discrimination, job demand, job certainty, safety compliance → physical symptoms → injury accidents (+) 4. Harassment /discrimination, job certainty, social support, skill underutilisation, safety responsibility, safety compliance → psychological strain → near misses (+)

(Continued)

Table 1.1 (Continued)

Source	Location	Sample	Variables	Findings
Lingard 2003	Australia	182 engineers	Job stressors (overload, responsibility, role clarity, role conflict, satisfaction with promotion, social satisfaction, job control and satisfaction with pay) Personality traits (neuroticism, extroversion, optimism, quick-wittedness and impulsiveness) Burnout (emotional exhaustion, cynicism, personal competence and professional worth) Turnover	1. Overload, role conflict, neuroticism, quick-wittedness, role clarity, promotional satisfaction → burnout (emotional exhaustion, professional worth) (+) 2. Promotional satisfaction, responsibility, extroversion, role clarity, pay satisfaction, neuroticism → burnout (cynicism, personal competence) (–) 3. Cynicism, emotional exhaustion → turnover intention (+)
Leung, Wong and Oloke 2003	Hong Kong	90 cost estimators	Personal background information Stress Problem-focused coping behaviours (control action, instrumental support seeking, preparatory action) Emotion-focused coping behaviours (escape, emotional discharge, religious emotional support)	1. Senior estimators normally apply problem-focused coping, while junior estimators prefer to seek emotional support from their religion 2. Senior estimators: instrumental support seeking → stress (–) 3. Junior estimators: religious emotional support → stress (–)

Haynes and Love 2004	Australia	100 project managers	Coping strategies Affect state Stress, depression, anxiety	<ol style="list-style-type: none"> 1. Work experience (-), project size (-), avoidance (+), active coping (-), positive affect (-), negative affect (+) → depression 2. Age (+), work experience (-), project value (-), social coping (+), avoidance (+), active coping (-), accepting (+), negative affect (+) → anxiety 3. Education level (+), work experience (-), project size (-), social coping (+), active coping (-), self-control (+), negative affect (+) → stress 4. Respondents who engaged in a more problem-focused style of coping were better adjusted than those who engaged in more emotion-focused behaviours
Lingard 2004	Australia	182 civil engineers	Job stressors Relationship satisfaction Burnout	<ol style="list-style-type: none"> 1. Relationship conflict (+), overload (+), role conflict (+), promotion satisfaction (-), role clarity (-), responsibility (-), job security (+) → burnout 2. Burnout was predicted by different variables among respondents in dual compared to single-income households and among parents and nonparents
Loosemore and Waters 2004	US	84 male and 47 female construction professionals	Factors intrinsic to job Managerial role factors Relationship to others Career and achievement factors Organisational structure and climate	<ol style="list-style-type: none"> 1. Men experience slightly higher levels of stress than women 2. Men appear to suffer more stress in relation to risk taking, disciplinary matters, implications of mistakes, redundancy and career progression 3. Female professionals often suffer from a lack of opportunities for personal development, poor rates of pay, keeping up with new ideas, business travel and the cumulative effect of minor tasks 4. These differences reflect women's traditional and continued subjugation in the construction industry
Siu, Philips and Leung 2004	Hong Kong	374 construction workers	Safety climate (safety attitudes and communication) Psychological strain (psychological distress and job satisfaction) Safety performance (accident rates and occupational injuries)	<ol style="list-style-type: none"> 1. Safety attitudes → occupational injuries (-) 2. Psychological distress → occupational injuries (+) 3. Job satisfaction → occupational injuries (-) 4. Psychological distress was found to be a mediator of the relationship between safety attitudes and accident rates

(Continued)

Table 1.1 (Continued)

Source	Location	Sample	Variables	Findings
Ng, Skitmore and Leung 2005	Hong Kong	97 construction professionals	Stressors (related to work nature, work time, organisational policy, organisational position, situational /environmental and relationships) Job demand (work hours, irregularity) Work-family conflict (emotional exhaustion, cynicism, professional efficacy) Burnout	1. Stressors which are most difficult to manage include bureaucracy, lack of opportunity, work-family conflicts and having different views from superiors 2. The patterns of stress manageability differ between clients, consultants and contractors 1. Work hours, irregularity → emotional exhaustion dimension (+) 2. Work-family conflict → emotional exhaustion (+) 3. Work-family conflict is a key mediating mechanism between job demands and emotional exhaustion for male employees
Lingard and Francis 2005	Australia	231 male construction professionals		
Leung et al. 2005a	Hong Kong	180 cost estimators	Stressors (personal, interpersonal, task, physical) Stress Stress	1. Work overload (+), role conflict (+), job ambiguity (+) and working environment (+) → stress 2. Work underload (-) → role conflict (+) → stress 1. Stress → weak interpersonal relationships, negative organisational relationship and ineffective process (+) 2. Stress → overall performance (-) 3. Stress → organisational relationship (inverted U-shape)
Leung et al. 2005b	Hong Kong	177 cost estimators	Performance (weak interpersonal relationships, organisational relationships, professional performance, ineffective processes and organisational relationship) Job demand Job control Social support (work and nonwork related) Job satisfaction Health	
Love and Edwards 2005	England	100 construction project managers		1. JDC-S model can significantly predict employees' psychological well-being in terms of worker health and job satisfaction among the construction project managers sampled 2. Nonwork-related support and work support → health (+) 3. Nonwork-related support and job control → satisfaction (+)
CIOB 2006	England	847 construction participants	Stressors (physical, organisational, job demand and job role)	1. 68.2% of respondents had suffered from stress, anxiety or depression as a direct result of working in the construction industry 2. Lack of privacy (43%), inadequate temperature controls (43%), lack of feedback (56.8%) poor communication (55.7%), inadequate staffing (55%), too much work (64.1%), ambitious deadlines (59.7%), pressure (59.9%) and conflicting demands (52.2%) → occupational stress

Lingard and Francis 2006	Australia	202 construction professionals	Work–family conflict Support (coworker, supervisory and perceived organisational support) Burnout (emotional exhaustion) Coping behaviours Stress Estimation performance (project performance, poor processes, good cooperation and interpersonal relationships)	<ol style="list-style-type: none"> 1. Organisational support is a moderator between work–family conflict and emotional exhaustion 2. Supervisory support (practical and criticism) is a moderator between work–family conflict and emotional exhaustion 3. Coworker support (practical) is a moderator between work–family conflict and emotional exhaustion <p>Senior estimators:</p> <ol style="list-style-type: none"> 1. Problem-focused coping behaviours (+), emotional-focused coping behaviours (–) → project performance 2. Stress → interpersonal relationships (inverted U-shape) <p>Junior estimators:</p> <ol style="list-style-type: none"> 3. Problem-focused coping behaviours (+), emotional-focused coping behaviours (+), stress (inverted U-shape) → project performance
Leung, Liu and Wong 2006	Hong Kong	210 cost estimators		<ol style="list-style-type: none"> 1. A significant relationship between quantitative and qualitative stress levels 2. Job demand stressors (work underload and work– home conflict) → qualitative job demand stress (+) 3. Qualitative job demand stress → quantitative stress (+) 4. Nonjob demand stressors (personal behaviour, poor environment, social support) → role conflict stressor (+) <ol style="list-style-type: none"> 1. The stress levels of both the professional estimators and other personnel are similar, with objective stress being significantly higher than subjective stress, which is in turn significantly higher than emotional exhaustion 2. Lack of autonomy (+), lack of feedback (–) → objective stress 3. Relationship conflict (+), lack of feedback (–), lack of autonomy (+) → subjective stress 4. Lack of autonomy (+), unfair reward and treatment (+) → emotional exhaustion
Leung, Sham and Chan 2007	Hong Kong	163 cost estimators	Stressors (personal behaviour, social support, role conflict, poor environment, work underload and work– home conflict) Job demand	
Leung, Skitmore and Chan 2007	Hong Kong	163 cost estimators	Stressors (personal, task, organisational and physical) Stress (objective and subjective and emotional exhaustion)	

(Continued)

Table 1.1 (Continued)

Source	Location	Sample	Variables	Findings
Meliá and Becerril 2007	Spanish	105 construction workers	Antecedent variables (leadership, role conflict and mobbing behaviour) Intervening variables (tension and burnout) Outcome variables (perceived quality, psychological health and propensity to leave) Job satisfaction Physical symptoms of stress Work-life conflict Turnover intention	1. Leadership → burnout (-); leadership → perceived quality (+) and propensity to leave (-) 2. Role conflict → tension (+); mobbing behaviour → burnout (+) 3. Burnout → perceived quality (-) and propensity to leave (+) 4. Tension → psychological health (-)
Sang, Dainty and Ison 2007	England	Architects	Job satisfaction Physical symptoms of stress Work-life conflict Turnover intention	Female respondents reported significantly lower overall job satisfaction and significantly higher physical symptoms of stress, work-life conflict and turnover intention
Leung, Chan and Olomolaiye 2008	Hong Kong	108 construction project managers	Stress (objective stress, burnout and physiological stress) Performance (task, interpersonal and organisational)	1. Objective stress → interpersonal performance (inverted U-shape), task performance (-), organisational performance (-) 2. Physiological stresses → organisational performance (U-shape relationship) 3. Burnout → task performance (+), organisational performance (U-shape relationship)
Leung, Chan, Chong and Sham 2008	Hong Kong	108 client and 68 contractor cost estimators	Stressors (Type A behaviour, social support, work underload, poor working environment, role conflict and private life) Stress	Stressors → stress 1. Poor environment, role conflict, work underload → stress (+) 2. Social support, Type A behaviour → stress (-) 3. Work underload → role conflict among cost engineers, supervisors and organisation → stress Deviations between two groups of cost engineers: 4. Private life → stress of contractors' cost engineers (+) 5. Closed interactive looping relationship among role conflict, Type A behaviour, work underload for contractors' cost engineers
Leung, Zhand and Skitmore 2008	Hong Kong	73 cost estimators	Stressors (personal, physical, organisational and task) Support (emotional, career development, reward, workgroup and superior) Stress	1. Lack of autonomy (+) and lack of feedback (-) → stress 2. Informal organisational support (emotional, workgroup and superior) → stressors (-)

Yip, Rowlinson and Siu 2008	Hong Kong	222 construction engineers	Four-factor model of coping strategies: rational problem solving, resigned distancing, seeking support/ventilation and passive wishful thinking Burnout: emotional exhaustion, cynicism and reduced professional efficacy Role overload	<ol style="list-style-type: none"> 1. Problem solving significantly moderated the relationship between role overload and all three dimensions of burnout 2. Moderating effect of resigned distancing and seeking support/ventilation was significant only for emotional exhaustion and cynicism, respectively 3. Passive wishful thinking failed to demonstrate a significant moderating effect on any of the burnout dimensions
Leung, Chan and Yu 2009	Hong Kong	108 construction project managers	Stressors (personal, physical, organisational and task)	Four critical stressors (work overload, poor interpersonal relationships, poor work environment and poor home environment) → subjective and objective stress (+)
Yip and Rowlinson 2009a	Hong Kong	403 construction professionals	Subjective and objective stress Long working hours, role overload, role conflict, role ambiguity, lack of autonomy and job security as significant job determinants of burnout	<ol style="list-style-type: none"> 1. Long working hours, role overload, role conflict, role ambiguity, lack of autonomy and job security → burnout (+) 2. Job redesign contributes to the reduction of burnout
Yip and Rowlinson 2009b	Hong Kong	249 construction engineers	Burnout (exhaustion, cynicism and diminished professional efficacy) Long working hours, qualitative overload, lack of promotion prospects, role conflict, role ambiguity and lack of job security	<ol style="list-style-type: none"> 1. Engineers working within contracting organisations report higher levels of burnout than their compatriots within consulting organisations. The results also showed that burnout could be attributed largely to the stressors associated with job conditions and work environments 2. For engineers in consultant organisations, qualitative overload and lack of promotion prospects → burnout (+) 3. For engineers in contracting organisations, long working hours, role conflict, role ambiguity and lack of job security → burnout (+)
Leung, Chan and Yuen 2010	Hong Kong	142 construction workers	Stressors (personal, interpersonal, physical, organisational and task) Job stress and emotional stress Injuries and accidents	<ol style="list-style-type: none"> 1. Emotional stress → injury incidents (+) 2. Work overload, inter-role conflict, poor physical environment, unfair reward and treatment, inappropriate safety equipment → emotional stress (+) 3. Poor workgroup relationships, work overload, inter-role conflict → job stress (+)

(Continued)

Table 1.1 (Continued)

Source	Location	Sample	Variables	Findings
Leung, Chan, and Chong 2010	Hong Kong	139 construction professionals	Chinese values (interpersonal integration, conservative personality, social conventions, disciplined work ethos) Stressors (task, organisational and interpersonal)	1. Valuing social conventions → role ambiguity, poor workgroup relationships (–) 2. Disciplined work ethos → work overload (+), poor workgroup relationships, work underload (–) 3. Conservative personality → work overload (–) 4. Valuing interpersonal integration → disciplined work ethos (+), social conventions (+) → stressors 5. Poor working environment → poor workgroup relationships, role ambiguity (+)
Love, Edwards and Irani 2010	Australia	449 construction professionals	Stress (self, situational and work) Support (Self, situational and work) Mental health (good and poor)	1. Staff of contracting organisations working onsite reported higher levels of poor mental health and greater work stress than consultants 2. Staff onsite experienced greater levels of self-induced stress, whereas consultants reported higher levels of self- and work support 3. For consultants: work support → poor mental health (–) 4. For consultants: self, situational and work support → good health (+) 5. For contractor staff: self-support → good mental health (+) High volume of work, uncomfortable site offices, lack of feedback on previous and ongoing building projects and variations in the scope of work in ongoing building projects → stress (+)
Ibem et al. 2011	Nigeria	107 construction professionals	High volume of work, uncomfortable site offices, lack of feedback on previous and ongoing building projects and variations in the scope of work in ongoing projects	1. Job stress → burnout (+), task performance (–) 2. Physiological stress → organisational performance (–) 3. Burnout → physiological stress (+), organisational performance (–)
Leung, Chan and Dongyu 2011	Hong Kong	108 construction professionals	Stress (job stress, burnout, physiological) Performance (task, interpersonal and organisational)	
Leung and Chen 2011	Hong Kong	45 cost estimators	Stress (objective and emotional) Commitment (affective, continuance and normative)	1. Stress → commitment (–) 2. Objective stress → normative commitment (–) 3. Emotional stress (–) → affective commitment (–), normative commitment (–)

Mostert, Peeters and Rost 2011	South Africa	529 construction professionals	<p>Job demand (pressure)</p> <p>Job resources (autonomy, colleague support, supervisor support)</p> <p>Work-home inference (WHI) (positive and negative)</p> <p>Burnout (exhaustion and cynicism)</p> <p>Engagement (vigour, dedication)</p> <p>Stress (physical and emotional)</p> <p>Coping behaviours (problem- and emotion-based)</p> <p>Organisational support (adjustment, career and financial)</p>	<ol style="list-style-type: none"> 1. Job demand → negative WHI (+) and burnout (+) 2. Job resource → positive WHI (+) and engagement (+), while → negative WHI (-) and burnout (-) 3. Negative WHI → burnout (+), while positive WHI → engagement (+)
Chan, Leung and Yu 2012	Hong Kong	40 construction professionals	<p>Stress (physical and emotional)</p> <p>Coping behaviours (problem- and emotion-based)</p> <p>Organisational support (adjustment, career and financial)</p>	<ol style="list-style-type: none"> 1. Hong Kong expatriate construction professionals in mainland China from all groups had experienced stress in their expatriate assignments. 2. Identification of three problem-focused (planful problem solving, confrontive reappraisal and instrumental support seeking) and three emotion-focused (emotional discharge, escapism-avoidance and social support seeking) coping strategies 3. Identification of three forms of organisational support (adjustment, career and financial) 4. Coping strategies and organisational support for expatriate and nonexpatriate groups were compared
Lingard, Francis and Turner 2012	Australia	261 construction workers	<p>Work-family conflict (time- and strain-based work interference with family life and time-/strain-based family interference with work)</p> <p>Control</p> <p>Supervisor support</p> <p>Work-family enrichment</p>	<ol style="list-style-type: none"> 1. Work time demands → time- and strain-based work interference with family life (+), time- and strain-based family interference with work (-) 2. Work-family enrichment → work time control (+), supervisor support (+), time- and strain-based work interference with family life (+), time- and strain-based family interference with work (-) 3. Respondents with high work time demands and low work time control (or low supervisor support) reported the highest levels of time- and strain-based work interference with family life 4. The lowest levels of work interference with family life were reported by respondents whose jobs were classified as low work time demand and high work time control (or high supervisor support)

(Continued)

Table 1.1 (Continued)

Source	Location	Sample	Variables	Findings
Leung, Chan and Yu 2012	Hong Kong	395 construction workers	Organisational stressors (unfair reward and treatment, inappropriate safety equipment, provision of training, lack of goal setting and poor physical environment) Stress (emotional and physical) Safety behaviours Injury incidents	<ol style="list-style-type: none">1. Safety behaviours (–) and lack of goal setting (+) → injury incidents2. Emotional stress (inverted U-shape), physical stress (+), inappropriate safety equipment (+) → safety behaviours3. Provision of training (+), inappropriate safety equipment (+) → emotional stress4. Inappropriate safety equipment (+) → physical stress
Leung and Chan 2012	Hong Kong	40 construction professionals	Interpersonal, task, organisation and physical stressors	<ol style="list-style-type: none">1. Identification of four types of stressors: interpersonal, task, organisation and physical2. Compares stressors of Hong Kong expatriate construction professionals with that of their compatriots based in Hong Kong3. A stressors model is developed for Hong Kong expatriate construction professionals
Boschman et al. 2013	Netherlands	262 construction workers and 310 construction supervisors	Psychological work characteristics (job demand, job control, social support, job variety and future perspective) Short-term effects of the work day (need for recovery and fatigue during work) Long-lasting effects (distress, depression and posttraumatic stress disorder (PTSD))	<ol style="list-style-type: none">1. Construction workers experienced worse job control, job variety and future perspectives (statistically significant); Supervisors experienced higher job demand and need for recovery (statistically significant)2. Mental health effects among bricklayers and supervisors, respectively, were as follows: high need for recovery after work (14%; 25%), distress (5%, 7%), depression (18%, 20%) and PTSD (11%, 7%)3. For both construction workers and supervisors, job demand → depression (+)4. For supervisors, job control and social support → depression (+)

Bowen, Edwards and Lingard 2013	South Africa	590 construction professionals	<p>Job demand factors (tight deadlines, long hours, inadequate time, work–family conflict, kept occupied, need to work harder)</p> <p>Job control factors (type and pace of work and environment)</p> <p>Support at work (supervisor and colleague support)</p> <p>Job demand factors</p> <p>Job control factors</p> <p>Support at work</p> <p>Discrimination in terms of salary and job security, based on language, race, religion, gender, sexual preference</p> <p>Organisational climate in terms of interpersonal relationships, compensation for work, job stability, etc.</p> <p>Psychological stress</p> <p>Social stress</p> <p>Physical stress</p> <p>Drug use</p>	<ol style="list-style-type: none"> 1. Construction professionals in South Africa experience high levels of stress at work 2. Architects suffer from more stress than other professionals (engineers, quantity surveyors and project managers). They experience tight deadlines, long working hours and a feeling of being kept occupied. Architects also have more control over their work types and working environment 3. Female professionals feel more stressed than males
Bowen, Govender and Edwards in press	South Africa	676 construction professionals	<p>Discrimination in terms of salary and job security, based on language, race, religion, gender, sexual preference</p> <p>Organisational climate in terms of interpersonal relationships, compensation for work, job stability, etc.</p> <p>Psychological stress</p> <p>Social stress</p> <p>Physical stress</p> <p>Drug use</p>	<ol style="list-style-type: none"> 1. The terminal consequence of occupational stress is not substance use but rather psychological, physiological and sociological strain effects 2. Organisational climate is largely determined by gender, job demand and control and support factors 3. Age, gender, level of job control and organisational climate are significant predictors of discrimination 4. Psychological strain is significantly predicted by age, job demand and job control factors and by organisational climate 5. Sociological strain is determined by age, job demands, discrimination and psychological strain 6. Age and sociological and psychological strain effects behave as significant predictors of physiological stress effects
Poon et al. 2013	Hong Kong;	32 construction personnel	<p>Bureaucratism</p> <p>Drug use</p> <p>Physical stress</p> <p>Psychological stress</p> <p>Social stress</p> <p>Organisational climate</p> <p>Job control factors</p> <p>Support at work</p> <p>Discrimination in terms of salary and job security, based on language, race, religion, gender, sexual preference</p> <p>Organisational climate in terms of interpersonal relationships, compensation for work, job stability, etc.</p> <p>Psychological stress</p> <p>Social stress</p> <p>Physical stress</p> <p>Drug use</p>	<ol style="list-style-type: none"> 1. Bureaucratism of the safety management system, underevaluation of the contribution of safety personnel and rivalry manoeuvring have an adverse effect 2. Good working relationships, quality of workforce and company organisational culture → burnout (+) 3. It is worth noting that an individual's ability to dilute and accept the burnout effect plays a key role in their final reaction

On the other hand, 23 of the studies also investigate the sources of stress (*stressors*). The most common stressors studied in the construction industry context are task or job related, including work overload, job demands, job control, tight schedules, compensation imbalance, role and conflict (Bowen, Edwards and Lingard 2013; Goldenhar, Williams and Swanson 2003; Leung et al. 2008; Ng, Skitmore and Leung 2005). Moreover, personal (such as dealing with Type A behaviours, communication problems and work-home conflict), organisational (such as organisational support) and physical stressors (such as a poor working environment) are also addressed (Leung, Chan and Yu 2009; Leung, Chan and Yuen 2010; Lingard, Francis and Turner 2012; Sutherland and Davidson 1993).

To deal with stress in work and daily life, construction personnel need to adopt various *coping behaviours* in the context of project management (Chan, Leung and Yu 2012; Haynes and Love 2004; Leung, Wong and Oloke 2003; Leung, Liu and Wong 2006; Yip and Rowlinson, 2008). Studies show that senior construction personnel under stress tend to apply problem-based coping behaviours (instrumental support seeking, direct/active action and preparatory action), while junior personnel prefer emotion-based coping (escape, emotional discharge and emotional support) (Leung, Wong and Oloke 2003; Leung, Liu and Wong 2006). These results also indicate that problem-based coping behaviours are more effective in reducing stress and enhancing performance, whereas emotion-based coping actually increases stress (Haynes and Love 2004; Leung, Liu and Wong 2006).

The effect of stress on the *performance* of construction personnel in different disciplines has also been receiving increasing attention of late (Djebarni 1996; Leung et al. 2005b, Leung, Chan and Olomolaiye 2008). Fifteen studies investigate this issue, with four dealing with safety performance in the UK and Hong Kong, three addressing job satisfaction in the UK, two covering turnover intention in Australia and Spain and six papers looking at performance in general in the UK, Australia and Hong Kong. Stress is shown to be negatively related to performance for construction professionals (Goldenhar, Williams and Swanson 2003; Lingard 2003), while an inverted U-shape relationship between stress and ultimate performance has also been identified (Djebarni 1996; Leung et al. 2005b; Leung, Liu and Wong 2006).

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