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A practical tool for estimating compulsory OHS costs of residential building construction projects in Turkey

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ABSTRACT

Construction industry is playing the most important role in the economic development not only in Turkey, but also in all developing countries. Turkish construction industry has reached its climax in the last 20 years with 7.4% share in total employment and 11.5% growth in terms of GNP in recent years. Parallel to this growth, there has been an increase in the number of occupational accidents in Turkish construction industry as well. Small or middle scale residential projects have a big share in the industry and majority of fatal accidents usually occur on such work sites. This study focuses on compulsory investments of small or middle scale residential building construction projects such as safety staffing costs on-site, formal safety training courses, PPE, safety facilities and fee for laboratory examinations in employment procedures of workers. Based on these subcomponents of OHS measures, an extensive literature review has been made to single out specific risks and the measures to prevent those risks. These specific parameters are then incorporated into an existing computer program, which had been originally designed to calculate direct construction costs only. By calculating and making a budget for the cost of prevention at the beginning of construction projects, it provides a better understanding of safety costs during a building construction project implementation. Thus, it helps efforts to reduce loss of workers' life and the mitigation of safety costs arising from severe injuries, fatalities, administrative procedures, legal obligations and litigation costs and expenses. The efficacy of the developed computer program is also tested on a construction project. The results reveal that the percentage of compulsory OHS costs to the direct construction costs is 5.15%, and OHS cost per unit area is approximately 8.47 USD/m^2.

1. Introduction

Construction industry is playing the most important role in the economic development not only in Turkey, but also in all developing countries. In recent years with contribution of the Housing Development Administration of Turkey (TOKİ), the Turkish construction industry has reached its climax in the last 20 years with 7.4% share in total employment and 11.5% growth in terms of GNP in 2013 (TUIK, 2013). Parallel to this growth, there has been an increase in the number of occupational accidents in Turkish construction industry as well. Such undesirable incidents have always been common in all industries; however, they are particularly problematic in the construction sector.

Fundamental changes about public procurement system, building audit regulations and work environment were made between 2001 and 2012 in Turkey. With the added momentum of European Union (EU) accession process during that period, it was aimed to enhance the safety of workers and properties in construction sector by establishing healthy and safe working environments and effective audit mechanisms in line with EU norms and standards. In this context, procedures and principles about taking necessary precautions in health and safety at work and establishing an efficient inspection mechanism during conceptual design and construction period are reconsidered in order to build quality buildings in accordance with the development plans and standards, and in line with the rules of science, art and hygiene. Despite many legal regulations, thousands of construction accidents that result in deaths, injuries and permanent incapacity, continue to occur every year because sensitivity to such issues is not at a satisfactory level in this industry, where safety is regarded as an unnecessary expenditure requiring extra cost. More precisely, on account of maximum profits, sustainability and economic competitiveness, many contractors content only with basic safety requirements and shy away from training programs during construction period (Cheng et al., 2010a).

This paper provides the details of computer software developed as part of a doctoral thesis. The aim is to estimate the safety costs for residential building construction projects by adding a new software module to an existing computer program which had been developed for

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cost estimation by one of the authors decades ago. Calculating and making a budget for the cost of accident prevention at the beginning of construction project helps us better estimate the safety costs involved in a building construction project. Thus, the program is not only instrumental in decreasing the number of occupational accidents but it also helps minimize safety costs by reducing administrative red tape and litigation expenses (Gürcanlı et al., 2015). What is more, it provides contractors an opportunity to manipulate their bids by changing level of source assignment and construction period in a tender.

2. Literature review

Cost estimation is defined as forecasting the actual costs of a building construction project with short-term studies under specific conditions (Yaylagül, 1994). The concept of actual costs involve all kinds of costs encountered in each period of building such as conceptual design, planning, programming, detail designing, constructing, using and demolishing period (Bostancıoğlu, 1992). Models of cost estimation in the initial design stage of a construction project are used for forecasting the amount of financial resource of a project or for limiting the design criteria within the resources allocated (Kim et al., 2004). In the early stages of construction projects, cost estimations with minimum project information allow owners and planners to prevent waste of money and time, and to control costs effectively in detailed project design work. Although there are many cost estimation models mentioned in the literature, there is unfortunately no standard for these cost estimation models of a building construction project, not only in Turkey but also all around the world (Arpacı, 1995; Cook, 1982; Cox, 1987; Curran, 1989; Çıracı et al., 1996; Feng et al., 2015; PMBOK, 2008; Polat, 2004; Seyyar, 2000; Usta, 1994). There are different models used in each stage of building construction period to estimate and control costs. The concept of cost estimation model was firstly submitted to plan residential and public buildings in Europe in 1950s. Cost estimation models based not only on statistics (Singh, 1990; Wilson, 2005) but also on linear regression analysis (Kouskoulas and Koehn, 1974) had been studied in 1970s. Expert system based cost estimation models have become common in the early 1980s (Kim et al., 2004). Nowadays these models are divided into four groups like traditional models, descriptive models, realistic models and information systems models.

For too long, costs of accidents have been included in cost estimation of construction projects because the construction industry has largely viewed accidents as the cost of doing business. The costs of health and safety are divided into two categories (Fellows et al., 2002). The first is the 'costs of accident prevention (health and safety measures)'. According to the Health and Safety Executive (HSE) (2004), Tang et al. (2004) and Ferret and Hughes (2007), they are expenses made directly by contractors themselves in order to prevent accidents. The second is costs that arise from the occurrence of (direct and indirect) accidents which occur even after required safety measures have already been taken. Heinrich (1931), who pioneered the study on costs of accident, classified the costs into two groups as direct and indirect costs. Direct costs of accident refer to expenditure whenever an accident occurs including insurance, damage to building, product, equipment or vehicle, expenses for medical care, legal investigation, and expenditures stemming from death, permanent disability, worker illness and losses of current production. Indirect costs of accident include cleaning up after the accident occurs, costs of hiring temporary equipment and labor, disposal of waste material, costs of advising and consulting experts, lost time, sick pay, overtime working, loss of business, costs of accident prevention reputation (Ferret and Hughes, 2007; Oxenburgh and Marlow, 1996; Tang et al., 2004; Everret and Frank, 1996). In a study undertaken by HSE, it was shown that indirect costs could be 36 times greater than the direct cost of an accident. As Cheng et al. (2010b) states that the direct costs of an accident represent the tip of the iceberg, when compared to overall costs.

The costs of accident prevention are the costs of those resources which are spent by contractors in their attempt to implement health and safety measures with the purpose of complying with health and safety requirements. The costs of prevention include expenses for safety planning, acquisition of protective installations and equipment, training of personnel, payments for safety personnel, safety measurement and accident investigations (Laufer, 1987). These costs are classified into three types (fixed prevention, variable prevention and unexpected prevention costs) by Brody et al. (1990). Today, the costs of accident prevention are called as cost of Occupational Health and Safety (OHS) or safety investments. The components of total safety investments are safety staffing costs (C_1) [on-site module (C_{11}) and head office module (C_{12})]; safety training costs (C_2) [formal safety training courses (C_{21}) and in-house safety training (C_{22})]; safety equipment and facilities costs (C_3) [Personal Protective Equipment (PPE) (C_{31}), safety facilities (material and machinery) (C_{32}) and safety facilities (manpower) (C_{33})]; safety committee costs (C_4) [budget for safety committees (C_{41}) and time lost due to safety committees activities (e.g. meetings and inspections) (C_{42})]; safety promotion and incentive costs (C_5) [safety promotion costs (C_{51}) and safety incentive costs (C_{52})] and costs of new technologies, methods or tools designed for safety (C_6) (Laufer, 1987; Hinze, 1991; Tang et al., 2004; Teo and Feng, 2011).

Nowadays, thanks to strategic management, performance criteria such as quality, customer satisfaction, productivity, sustainability and OHS have gained prominence. However, it is not possible to collect data with traditional cost systems to evaluate these criteria of an organization. Therefore an activity-based costing is suggested as a new approach by Cooper and Kaplan (1992), which allows us to obtain information on cost items that are ignored in traditional methods and gives more accurate information especially in complex structures (Rzvi and Elnathan, 1999). Moreover, this method provides detailed information about the cost of activities in a particular process (Khataie et al., 2011) and is flexible for all kinds of business systems (Alkan, 2005; Liu and Pan, 2007). Ríos-Manríquez et al. (2014) state that firms can compare themselves to other firms in terms of cost control, profitability and productivity by utilizing this method.

Studies about the costs of OHS as part of project costs in construction industry are not very common. Costs of OHS and costs of accidents during a construction project were compared by Tan (1999) in Turkey. In 2010, the ratio of OHS costs to overall costs of 25 residential building construction projects was determined by Korkutan (2010). Aminbakhsh et al. (2013) used Analytic Hierarchy Process (AHP) in safety risk assessment during planning and budgeting phases of construction projects. After Chalos (1992) introduced the cost-benefit analysis of accident prevention as a new model, Tappura et al. (2015) incorporated human life as a critical/high value into this model. Alonso et al. (2013) investigated the impact of OHS on the investment of construction firms by administering a questionnaire in Spain. Sousa et al. (2014) presented a risk-based management of occupational safety and health for estimating of statistical costs of OHS in the construction industry. Considering safety costs as part of project costs and calculating them by using activity-based risk assessments method along with activity-based cost analysis, Gürcanlı et al. (2015) offered a new approach for determination of OHS costs.

OHS costs are not generally calculated during the bidding period, the contractors do not want to waste their financial resources for safety expenses or cut down on their contract profits during implementation period of construction projects. However, meeting timelines is a vital problem in cost estimation during the bidding period to calculate project management actions effectively. Estimating the costs of prevention actually involves further challenges for contractors; but it is impossible to judge whether money spend on prevention is justified in economic terms unless one knows what the prevention costs are beforehand. The objective of this paper is to offer a computer program as a practical tool for calculating OHS costs accurately ahead of time. The computer program is very useful to estimate both the overall costs and OHS costs of construction projects. Hence, by using this tool, contractors can more