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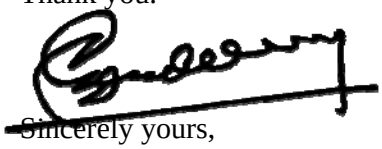

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AUTOMATED SAFETY PLANNING ON CONSTRUCTION SITE

SAMANEH ZOLFAGHARIAN

A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Construction Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

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This is dedicated to my loving, caring, understanding and supporting husband, Mehdi. Thank you for being a pillar of my strength. This dissertation is also dedicated to my family. A special feeling of gratitude goes to my loving parents whose words of encouragement and full support over the years has helped to finish this important chapter of my life. You are the most precious thing I have in this world. I love you dearly.

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ABSTRACT

Construction industry is considered as a dangerous industry because a large percentage of fatal accidents are recorded in it. It is reported that poor-safety awareness of project managers is one of the root causes of construction accidents. Thus, developing a program for promoting the knowledge of construction managers is crucial. This research developed an automated safety-planning prototype that can be used to mitigate occurrence of accidents on construction sites. To achieve this aim, frequency and severity of the common construction hazards were collected by distributing an online questionnaire among 300 construction safety managers, safety experts, and safety officers. Then, level of risks related to each hazard was calculated based on the relevant risk matrix. Ten interviews with expert panels were conducted to establish a relationship between hazards and construction activities and also to determine the most common construction activities in residential building within Malaysia. The results of this study reveal that the riskiest hazards on construction sites are lack of appropriate attitudes, lack of awareness of safety regulations, poor safety awareness in a project manager, and lack of knowledge. The results of this stage were implemented in developing the prototype. The prototype extracts current construction activities from schedules in Microsoft Project in order of their risks. Moreover, safety regulations and hazards related to each activity could be reported both in manual and automatic mode. The result of the prototype evaluation demonstrates that the prototype is innovative, efficient, and helpful in preventing construction accidents by promoting the project mangers' knowledge.

ABSTRAK

Industri pembinaan merupakan antara industri yang mempunyai pelbagai aktiviti merbahaya. Adalah di lapurkan kurang nya kesadaran tentang keselamatan di kalangan pengurus projek adalah salah satu punca utama kemalangan di tapak bina. Oleh itu adalah penting untuk membuat program keselamatan yang dapat di guna kan oleh pengurus projek bagi mengurangkan kamalangan yang boleh berlaku. Tujuan penyelidikan ini ini adalah untuk menghasilkan prototaip perancangan keselamatan yang otomatik yang boleh di gunakan untuk mengurangkan kemalangan di tapak bina. Untuk mencapai tujuan kajian ini, kekerapan dan keseriusan risiko pembinaan di kumpulkan melalui kaji selidik ke atas 300 pengurus projek, pegawai keselamatan pekerjaan dan pakar keselamatan pekerjan. Data-data kemudiannya dianalisis menggunakan kaedah Analisis Kekerapan , Analisis Indeks Purata dan Matrik Risiko. Hasil kajian menunjukkan risiko yang paling tinggi di tapak bina adalah sikap kurang mengambil berat, kurang kesadaran dan kurang pengetahuan tentang peraturan keselamatan. Prototaip yang di hasilkan dapat menyenaraikan aktiviti projek dari jadual Microsoft Project dan menyenaraikan risiko yang berkaitan. Hasil penilaian prototaip ini menunjukan ianya satu yang inovatif, cekap dan dapat membantu pengurus projek meningkatkan keselamatan di tapak bina.

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LIST OF ABBREVIATIONS

HSE	-	Health and Safety Executive
CCOHS	-	Canadian Centre for Occupational Health and Safety
SPSS	-	Statistical Package for Social Science
RBTs	-	Risk-Based Technologies
PM	-	Project Management
MS	-	Microsoft Project
VBA	-	Visual Basic for Application®
CWA	-	Cognitive Work Analysis
WDA	-	Work Domain Analysis
AH	-	Abstraction Hierarchy
ConTA	-	Control Task Analysis
DL	-	Decision Ladder
STRA	-	Strategies Analysis
SOCA	-	Social Organization and Cooperation Analysis
WCA	-	Worker Competencies Analysis
SRK	-	Skill, Rule, and Knowledge
SBB	-	Skill-Based Behavior
RBB	-	Rule-Based Behavior
KBB	-	Knowledge-Based Behavior
FOC	-	Frequency of Occurring
SD	-	Standards Deviation
SEV	-	Severity of the effects of accident or consequences

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Construction is often the largest source of employment in any country (Bust et al., 2008). It has been well documented that a large number of accidents have been recorded in this industry (Bust et al., 2008; Camino et al., 2008; Gregory and Simon, 2006a; Wang et al., 2006). In modern society, the construction industry has been defined as a dangerous industry (Liao and Perng, 2008; Niza et al., 2008). In Korea, the construction industry accounted for less than 10% of gross domestic product in 2007, while its occupational fatalities accounted for 20% of total fatalities (Kim et al., 2010). In Taiwan, occupational fatalities accounted for 0.29 deaths per thousand construction employees in 2005, which was a much higher than fatality rate than that of all other industries (Cheng et al., 2010). In Hong Kong, the construction accident rate was approximately 68.1 per 1000 workers, which is high compared to other industries (Ling et al., 2008).

The first essential step to mitigate construction accidents and manage safety is safety planning, which consists of identifying all probable hazards and safety measures. As such, this safety planning should be executed before conducting each construction activity in order to identify required safety measures. It is possible to improve safety planning into safety risk management by determining safety hazards,

classifying risks, controlling the risks and monitoring implementation (Chantawit et al., 2005).

It is critical to identify hazards that threaten workers (Yi and Langford, 2006). One of the most critical factors in serious and mortal accidents is a lack of understanding about risk and hazards on a construction site (Dejus, 2007a). While risks cannot be removed entirely, they should be effectively identified and assessed (Smith, 1999). In order to manage and control construction hazards, consideration should be given to the prevention of hazardous events and efforts to limit the severity of occurred hazards (Gregory and Simon, 2006a).

1.2 Statement of the Problem

Construction safety accidents have serious financial and humanitarian impacts (Dorji et al., 2006) such as “wasted cost”, “reduced productivity”, “declining company reputation”, and a “negative psychological impact on workers” (Mohamed, 1999; Tam et al., 2004). Meanwhile, excessive or unnecessary safety measures in order to mitigate construction safety accidents may also result in both delays in schedule and costs overruns (Yi and Langford, 2006).

Poor safety management is considered one cause of construction accidents. The construction manager, as a key project member, should know the most hazardous and risky conditions to mitigate accidents, optimize cost and time, and promote quality of production (Chantawit et al., 2005). Management needs a reliable database to provide comprehensive safety measures and hazards. Such a system will enable managers to be aware of real-time hazards and risks in order to promote safe performance on their construction sites. However, there unfortunately is no pattern for construction managers to follow to ensure safety on projects (Dejus, 2007a).

1.3 Aim and Objectives of the Study

The aim of this study is to propose a prototype for automated safety planning to mitigate occurrence of accidents in the construction industry. To achieve this aim, the following objectives have been identified:

i. To investigate the frequency and severity of construction safety hazards;
ii. To determine risks of construction safety hazards;
iii. To establish a relationship between safety hazards and common construction activities;
iv. To investigate the application of cognitive work analysis in construction safety domain; and
v. To develop a prototype for automated safety planning in construction projects.

1.4 Scope of the Study

To achieve the objectives of this study, the following scopes of work are considered:

i. This study considers five common construction activities related to Malaysian residential buildings;

ii. This study is limited to the design stage of the system development life cycle, namely prototyping and feedback.

iii. The system development life cycle is the process of developing information systems through investigation, analysis, design, testing, implementation, and maintenance (Bosworth and Kabay, 2002). This study is limited to investigate first stage which includes gathering required information and data, and also

design stage which contains flowcharting, prototyping, and also customer acceptance (see Figure 1.1).

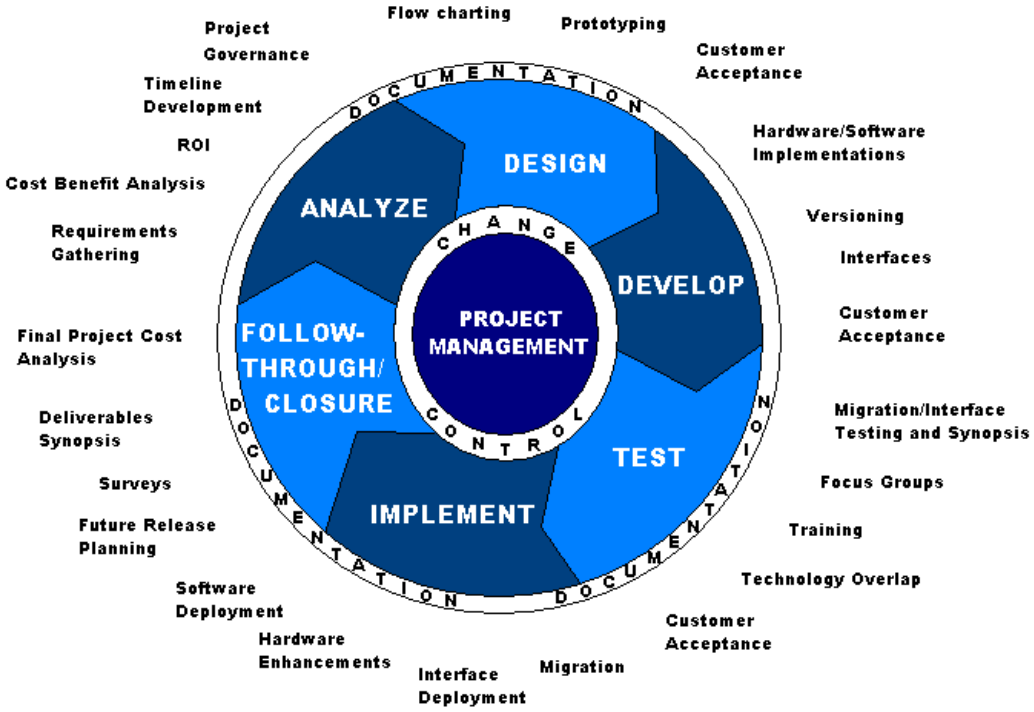

Figure 1.1 System Development Life Cycle_ adopted from: (Gaudsmith, 2011)

1.5 Methodology

To fulfill the research aims and objectives, the following procedures and methods will be employed (see Figure 1.2):

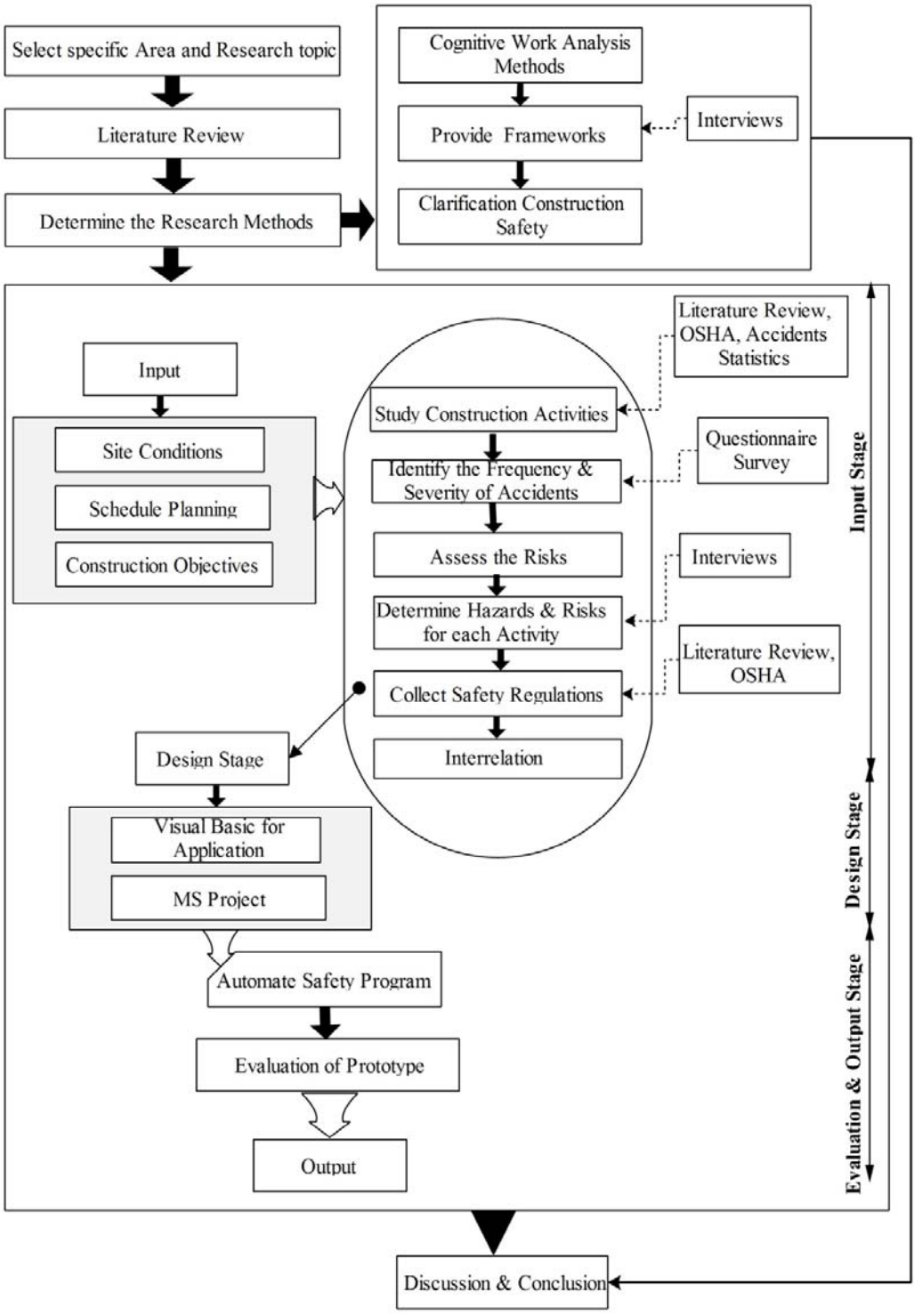

Figure 1.2 Methodology of the Research

1.5.1 Selecting Specific Research

The selection of topics was accomplished by investigating recent research trends and also through discussions and interviews with members of the construction industry. The findings of this stage were used to establish a new research direction, and ensure that the results of the research area would help improve construction safety.

1.5.2 Literature Review

Literature reviews were carried out to acquire the principal knowledge of the research topic. The sources involved in the literature reviews were published books, journals, and conference papers.

1.5.3 Determining the Research Methods

The research methods were determined by the constraints of a tight schedule, availability information on the research topic, efficiency of programming, and the time required for collection of data for analysis.

The initial work made the research objectives attainable. The following methods of investigating the problems are discussed in more detail.

1.5.3.1 Input Stage

The formation of the components of the construction objectives were defined after questionnaires, interviews, and discussions with workers, then the relationships between the elements were generated.

1.5.3.2 Design Stage

The main function of the design stage is the automation of safety on a construction site.

1.5.3.3 Evaluation Stage

In the evaluation and selection stage, the prototyped application was assessed.

1.5.3.4 Output Stage

The final automated prototype was generated.

1.5.4 Cognitive Work Analysis

This section of the research process was explained in chapter 4.

1.5.5 Discussion and Conclusion

The analysis of the results was proof of the feasibility and efficiency of the proposed program.