



A PERFORMANCE-BASED APPROACH TO  
EVACUATION ANALYSIS: A CASE STUDY OF  
TWO SHOPPING CENTRES.

BY

NORMALA BINTI SULLIAMAN

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for the degree of Master of Sciences in Building Services  
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Malaysia

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## **ABSTRACT**

This study is focused on exploring the capabilities and output of computer modeling in two shopping centres in Malaysia. In this study, the software SIMULEX is used to analyse Total Evacuation Time (TET) and occupant behaviour when the building is evacuated using the performance-based approach. So far, this software has not been used in Malaysia. In presence of new and complex projects, the prescriptive code used for the design of a performance of egress-system is not longer appropriate. Therefore, computer modeling based on performance-based approach is used to design an emergency safety for occupant. However, due to time constraint, this study only focused on Malaysia standard prescriptive code Uniform Building by Law (UBBL) 1984 using performance based approach by computer modeling software. Due to the limitations of study, the comparison between a real life fire drill and simulation could not be carried out and could be done for future work.

## خلاصة البحث

هذه الدراسة تركز على استكشاف القدرات والنتائج لنماذج الحاسب الالى فى اثنين من مراكز التسوق فى ماليزيا. فى هذه الدراسة تم استخدام برنامج الحاسب الالى سيموليكس لتحليل الزمن الكلى للاخلاء وسلوك السكان فى حالة اخلاء المبنى باستخدام نهج يعتمد على الاداء. حتى الان هذا البرنامج لم يتم تطبيقه فى ماليزيا, فى ظل وجود مشاريع جديدة وضخمة فان الشفرة الالزامية المستخدمه لتصميم اداء نظام الخروج لم تعد مناسبة, لذلك فان نموذج الحاسب الالى المصمم على نهج يعتمد على الاداء يستخدم لتصميم سلامة السكان فى حالة الطوارئ. مع ذلك نسبة لعامل الوقت فان هذه الدراسة تركز فقط على الشفرة الالزامية للمبانى الموحدة حسب المعايير الماليزية المضمنه فى القانون الماليزى لسنة 1984 باستخدام نهج يعتمد على الاداء بواسطة نموذج الحاسب الالى. نسبة لمحددات البحث فانه لم يمكن مقارنة حفر النار فى الطبيعة ومحاكاتها على برنامج الحاسب الالى ولم يمكن اجراءها فى الاعمال المستقبلية.

## **APPROVAL PAGE**

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of master in Building Services Engineering.

.....  
Puteri Shireen Jahn Kassim  
Supervisor

I certify that I have examined and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master in Building Services Engineering.

.....  
Maisarah binti Ali  
Examiner

This dissertation was submitted to the Department of Building Technology and is accepted as a fulfilment of the requirement for the degree of Master in Building Services Engineering.

.....  
Md Najib bin Ibrahim  
Head, Department of Building  
Technology

This dissertation was submitted to the Kulliyyah of Architecture and Environmental Design and is accepted as a fulfilment of the requirement for the degree of master in Building Services Engineering.

.....  
Khairuddin bin Abdul Rashid  
Dean, Kulliyyah of Architecture  
and Environmental Design

## DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Normala binti Sulliaman

Signature.....

Date.....

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CASE STUDY OF TWO SHOPPING CENTRES.**

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.....  
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Date

Dedicated with love to my husband Mohd Najib bin Esa and my children  
Nur Aida Shariza, Nor Aida Shazwani & Muhammad Ariff Azim.

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## LIST OF ABBREVIATIONS

UBBL 1984	Uniform Building By Law 1984
NFPA	National Fire Protection Association
TET	Total Evacuation Time
ASET	Available Safe Egress Time
RSET	Required Safe Egress Time
FE-FBA	Fire Engineering-Performance Based approach
ABCB	Australian Building Codes Board
KLIA	Kuala Lumpur International Airport
KLCC	Kuala Lumpur City Centre
BB Plaza	Bukit Bintang Plaza

# CHAPTER ONE

## INTRODUCTION

### 1.1 INTRODUCTION

Nowadays, the shopping complexes have grown like mushroom especially in town area due to high demand. People like to go to the shopping complex because it offer attractive place, provide facilities such as shopping, relaxing and so on. During weekend and festive seasons a lot of people spend their time at the shopping complex for varied purposes.

Base on author's experience, the exit path for large shopping complex is quite confusing. Dead end and dark corners are area which is difficult during emergency to evacuate should be eliminated at the design stage. According to Malaysian prescriptive standard, Uniform Building by Law (UBBL) 1984, dead end means an area from which escape is possible in one direction only and in an open plan it includes any point from which the direct routes to alternative exists subtend an angle of less than  $45^{\circ}$ .

When emergency such as fire disaster occurred, thousands of shoppers will panic, running in the mall desperately seeking for an exit. It is often that the shopping mall's design is concerned with aesthetics and the exits are hidden. When evacuating, people tend to use familiar exits, even though it might not be the best escape route. As panic increases, people may become physically aggressive, which only exacerbates the crisis (Human Behavior in Fire).

## **1.2 AIM OF THE STUDY**

The aim of this research is to explore the capabilities and output of SIMULEX in dealing with a large complex commercial building, in these two large shopping complexes in Malaysia.

## **1.3 RESEARCH OBJECTIVES**

Hence the objectives of this research are:

- i. To undertake an overview of the literature review and current research done in the field of evacuation and fire safety in particular the capabilities, advantages and limitations of evacuation tools
- ii. To explore the modeling, analysis and output capabilities of the emergency evacuation visualisation tool SIMULEX within the framework of two actual large shopping complex designs.
- iii. To test these design layouts against the output parameters in SIMULEX in terms of evacuation parameters and hence analyse the results in terms of safety parameters and the capability of producing visual analytical and numerical output
- iv. To give an overview of the basis of evacuation tool and assess whether it can realistically predict evacuation movement and parameters in a large building program.
- v. To report on problems and limitations encountered during these modeling and analysis exercises and studies.
- vi. To find the relationship between TET and no of exit and width

#### **1.4 PROBLEMS STATEMENT**

Shopping in shopping complexes is a modern trend. Due to its large area, the concern of fire safety particularly the exit route path is being questioned. Shopping complexes are usually visited by people who are familiar with the layout and also first time visitors who are not familiar with the layout thus the familiarity of the visitor toward the shopping complexes are different. Therefore, the exit route path such as exit signage and exit door should be located at suitable areas, easy to find and are not obstructed by the machines, banners or advertisements. This will reduce the visitors problem in finding the exit even for shopper who are familiar with the shopping complex.

The physical characteristic such as the door width, the numbers and width of the staircase, the width of protected corridor provided are also questions whether they are sufficient for occupants during evacuation in emergency especially for large areas. As mentioned before, when evacuating, people tend to use familiar exits, even though it is not the best escape route. Therefore, the entire exit route path should be designed properly in order to help occupants to evacuate quickly.

#### **1.5 SIGNIFICANT OF STUDY**

Standard prescriptive code give the minimum requirement that designer should follow during fire evacuation. However for certain areas such as means of exit path (such as width of exit and number of exit provided) the designer needs to find other alternative in order to convince the local authorities on life safety for the occupants. Therefore the finding of this research will contribute to the improvement of performance-based approach for evacuation strategies in Malaysia. It will also benefit the designer and engineer in maximizing the level of life safety of occupants during plan approval.

## **1.6 SCOPE AND LIMITATION OF STUDY**

This study only limited to the two selected shopping complex building due to time and research constrain. The selected shopping centre buildings are Bukit Bintang Plaza in Kuala Lumpur and Angsana Plaza in Johor Bharu. However, due to time and logistics, the shopping centers cannot be modeled as per in operation but as per designed. This is because the complexity of the tenants and retailers fit-out are too difficult for modeling. A long term observation and measured exercise need to be undertaken to gain enough information to model the shopping complex as in operation at the present time.

SIMULEX is a computer model which is capable to simulate the human movement and behavior. However the limitation of this software is that it does not consider the fire elements such as the fire spread, smoke spread, fuel load and etc. On other hand, the Total Evacuation Time (TET) obtained is based on every floor level because when the density of occupant is high, the occupant get 'stuck' at the link area and TET cannot be generated by SIMULEX.

There are many standard prescriptive related with the fire safety. However due to time constrain, only Malaysia prescriptive UBBL 1984 is discussed in this study. In order to achieve the research objective, this study focused on By-law UBBL 1984 in evacuation area only.

In literature review, no study has been conducted to evacuation of shopping complex using performance-based approach by computer modeling, no real fire drill data has been collected and compared with simulation result. Data in shopper characteristic in SIMULEX was selected as an input for the calculation of evacuation time.

The data for this research was based on two case studies of shopping complexes building. Therefore, the finding of this research cannot be generalized to other type of building usage such as hospitals, schools, offices and hotels also for other shopping complex.

## **1.7 DATA COLLECTION**

Two types of data were collected in this study. The first one is primary data which was taken during the interview with shopping mall management. The unstructured interview was organized in order to get the buildings' background and plan layout for both case study building.

Second, is secondary data which was obtained from the related sources such as journal, newspapers, articles from which the author to obtain information such as definition, concept, idea and etc. This information was used as references to the study and was presented in literature review in Chapter two.