



**Faculty of Information and Communication Technology**

**ENHANCED SNAPSHOT WITH INTELLIGENT OPTIMAL  
REPLACEMENT MODEL FOR HOSTEL MAINTENANCE  
MANAGEMENT BASED ON FAILURE DATA**

**Yuseni bin Ab Wahab**

**Doctor of Philosophy**

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MODEL FOR HOSTEL MAINTENANCE MANAGEMENT BASED ON FAILURE  
DATA**

**YUSENI BIN AB WAHAB**

**A thesis submitted**

**in fulfillment of the requirements for the degree of Doctor of Philosophy**

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2016**

## DECLARATION

I declare that this thesis entitle “Enhanced Snapshot Model with Intelligent Optimal Replacement Model For Hostel Maintenance Management Based on Failure Data is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : .....

## APPROVAL

hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Doctor of Philosophy.

Signature : .....

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Date : .....

## **DEDICATION**

### **Dear Allah**

I devoted my life and death to You, Allah. May my life is within your guidance.

### **My Parent**

**( Hj Ab Wahab bin Abdullah )**

Thank you for your sacrifice and love. No such compensate except from Allah.

### **My Beloved Wife**

**(Hairul Hazlina bte Mohd Ali )**

Your support, patience and encouragement give me strength to finish this study. May Allah  
bless us.

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Thank you for all the knowledge. May your knowledge are beneficial and useful for all  
humanity.

### **My Siblings**

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### **My Children**

**(Nur Adrina Batrisyia bte Yuseni )**

**(Nur Qaisara Khairina bte Yuseni)**

**(Mohammad Fareez Azeem bin Yuseni)**

May Allah guide and protect us to be good Muslim

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**LIST OF ABBREVIATIONS**  
**LIST OF ABBREVIATIONS AND GLOSSARY**

ACO – Ant Colony Optimizing  
AHP – Analytical Hierarchy Process  
AI – Artificial Intelligent  
CA – Criticality Analysis  
CI – Consistency Index  
CM – Corrective Maintenance  
CMMS – Computerised Maintenance Management System  
CR – Consistency Ratio  
CR – Redesign  
D – Detection  
DB – Detection Based  
DMG – Decision Making Grid  
ELSP – Economic Lot Scheduling Problem  
EMQ – Economic Manufacturing Quantity  
EPQ – Economic Production Quantity  
ESM – Enhanced Snapshot Model  
FMEA – Failure Mode and Effect Analysis  
FMECA – Failure Mode, Effect and Criticality Analysis  
FLRB – Fuzzy Logic Rule Based  
FTD – Failure Time Distribution  
GA – Genetic Algorithms  
GACO – Genetic Ant Colony Optimization  
HEI’s – Higher Education Institution’s  
HFM – Hostel Facilities Maintenance  
HORM – Hybrid Optimal Replacement Model  
HVAC – Heating a Ventilating and Air Conditioning System  
ICYM – International College of Yayasan Malacca  
IORM – Intelligent Optimal Replacement Model  
KUIM – University College of Islam Malacca



MCDM – Multi Criteria Decision Making  
MDT – Mean Downtime  
MHIMS – Multiple Hybrid Intelligent Management Systems  
MLE – Maximum- Likelihood Estimation  
MTBF – Mean Time Between Failures  
MTTF- Mean Time To Failure  
MYR – Malaysia Ringgit  
O – Occurrence  
OF – Operate to Failure  
OP – Operator Practice  
ORM – Optimal Replacement Model  
PM – Preventive Maintenance  
RI – Random Index  
RM – Replacement Maintenance  
RPN – Risk Priority Number  
S – Severity  
SS – Subjective Survey  
TPM – Total Productive Maintenance  
UiTM – University of Technology Mara  
US – Ultra Sonic  
WOL – Wear-Out Life

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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Malaysia is presently in the intermediary phase of growth and industrialization where many building tasks are being prepared. The project of public building includes educational buildings, hospital buildings and government buildings (Hilde and Theo Van, 2011; Wilkinson and Reed, 2010). A number of building defects have arisen and been reported officially by the mass media, with several relating to educational buildings (Mydin et al., 2014). There are numerous defects which are common to hostel building components, such as roofs, walls, floors, ceilings, toilets, doors and windows. These defects may cause unexpected accidents and even death (Soleimanzadeh and Mydin, 2013). For example, on 12 September 2005, a teacher fell to his death when a decayed plywood floor of a two- storey school block in SJK (C) Keat Hwa, Kedah gave away. It is believed that the floor was ruined by termites (Isa et al., 2011). Based on the cases reported, defects can be concluded as fatally disparaging and critical because they bring impairment to their users and the building itself, causing damage, serious injury and death (Susan Aryee, 2011). Therefore, a study is important to investigate the contributing factors of those defects in order to create a safe buildings (Khozaei, 2011; Wahab and Hamid, 2011). Then a remediation plan can be developed based on the respective defects and failure to mitigate the impacts and also improve current conditions (Mydin et al., 2011). Users, investors, and public officials became more concerned after hearing about critical incidents involving the sudden collapse and failure of infrastructure components. Public awareness of these incidents and identification of

potential failure areas have led to a perception of an infrastructure crisis (Naser et al., 2011). Table 1.1 provides failure issues, none of which are due to natural disasters, such as earthquakes or tornadoes, but are rather as a result of other causes, most probably lack of maintenance and repair, inadequate inspection and condition evaluation, insufficient funding, or more generally, inadequate management.

**Table 1.1 Examples of Infrastructure Failures**

<b>Infrastructure Crisis</b>	<b>Bad Impact</b>
4.12.2013 – Serdang Hospital ceiling collapse (www.utusan.com.my)	Four government employees were injured.
2.6.2009 – Sultan Mizan Zainal Abidin Stadium roof collapses (www.utusan.com.my)	Five construction workers were injured with three of them seriously hurt.
12.9.2005 – Teacher fell to his death from a decayed plywood floor of a two storey (Isa et al, 2011)	One death.
22.6.2015 – Mydin building collapse at Alor Gajah, Malacca: (www.thestar.com)	Three killed, six injured.
2001 – Highland Towers collapse was an apartment building collapse that occurred on 11 December 1993 in Taman Hillview, Ulu Klang, Selangor.	Up to 48 people were feared dead.
2002 – A school staircase collapsed in north China. (People’s Daily 2005)	21 teenage students died and 47 more were injured.
India: Eleven killed in Mumbai building collapse (4.8.2015) <a href="http://www.bbc.com/news/world-asia-india-33769472">http://www.bbc.com/news/world-asia-india-33769472</a>	At least 11 people died after a building collapsed near India's western city of Mumbai.

However, more cases have happened recently and many were not reported in media officially.

According to Peng et al. (2013) and Olanrewaju et al. (2010), failure has been defined as the incapacity of a constructed facility or its components to perform as the building collapse occurs when the entire structure or substantial part of it comes down: the structure loses its ability to perform its function .

In building maintenance the component is usually subject to deterioration with usage and age. Building component deteriorations can increase the risk of component failure and deteriorate the product quality. In the past several decades, various preventive maintenance policies, models and optimisation approaches have been proposed. Some reviews and recent literature on preventive maintenance are listed as follows: (Nishith et al., 2015; Xia et al., 2012; Doostparast et al., 2014; Zhong et al., 2014; Ding et al., 2015).

Preventive maintenance (PM) activities generally consist of inspection, cleaning, lubrication, adjustment, alignment, and replacement of subcomponents that wear out. In general, PM activities can be categorised in one of two ways, component maintenance or component replacement. It is clear that PM involves a basic trade-off between the costs of conducting maintenance and replacement activities and the cost savings achieved by reducing the overall rate of occurrence of system failures. Designers of PM schedules must prioritise these individual costs to minimise the overall cost of system operation. They may also be interested in maximising the system reliability, subject to some sort of budget constraint.

Preventive replacement is one effective strategy to reduce the probability of failure (reduce failure cost) and downtime in the deterioration condition. Öhman et al. (2015) stated that preventive replacement is the most appropriate maintenance strategy for a component which operates in the stage of wear-out life (WOL). However, the best time to carry out the preventive replacement must be considered. If preventive replacement is applied too frequently, the cost of maintenance and system downtime will increase. If preventive

replacement is only applied occasionally, it will increase the downtime of sudden failures (breakdowns) plus downtime for maintenance.

Hence, compromise between these two replacement conditions (too frequently and too occasionally) will result in the optimum time of replacement, which minimises the total system cost of downtime due to maintenance downtime and sudden failure downtime. An optimisation model is a mathematical model that refers to choosing the best solution from all feasible solutions. Optimisation models have been widely developed and used to find optimal PM and a replacement for a variety of systems.

Before the optimisation model is developed, it is essential to identify the maintenance problem. Several models are identified: for example, snapshot (Basari, 2009), FMECA (Hasbullah and Ahmad, 2015) and DTA (Jones et al., 2009). The purpose of maintenance problem identification is to find the cause of failure or fault, type of failure, effect due to the failure and prevention action. The output of the maintenance problem identification is the most critical components. These components will be used as a critical part to be modelled in order to find the optimal maintenance solution.

The establishment of artificial intelligence (AI) has the advantage of being useful in optimizing complex problems. There is enormous potential for developments in many applications of AI in maintenance by combining or hybridizing two or more AI techniques to select an appropriate model for analysis.

## 1.2 Problem Statement

Most hostel facilities maintenance have a maintenance model, such as maintenance schedule, maintenance plan, maintenance training and so on. This model assists in various facilities and areas in identifying problems in the university hostel such as component damage, cost, downtime, maintenance frequency, skill, and knowledge (Oladiran and Yaba, 2013). However, there is very little continuous maintenance management conducted to analyse the criticality of the hostel facilities. In addition, there is a lack of a specific model to look at cost effectiveness for the hostel facilities maintenance (HFM). Based on the stated issues, the identified problems of HFM are:

1. The most critical component in hostel facilities maintenance in Higher Education Institutions (HEI's) is still a lack of accuracy and misleading. According to Lind et al., 2012, maintenance problem identification based on the snapshot model in the case of failure data is essential for maintenance engineers to analyse the maintenance problems. In the current snapshot model, there is an analysis of the major fault type where each component is listed with the number of faults. For instance, if a component that develops the highest number of faults is identified, it will disrupt the maintenance work of the hostel facilities and this will incur cost and downtime. Thus, ranking such a component as the most critical one is misleading. Even though the ranking is established and proper analyses are conducted, an overall ranking based on all the criteria is not considered. This could have no meaning to the users (maintenance staff) and lead to wrong decisions (Burhanuddin et al., 2015). Deeper analysis also needs to be considered to increase the accuracy of maintenance problem identification which could affect the whole building component (Swallow, 2007).
2. The hostel facilities maintenance lacks a modelling method to identify the frequency of maintenance in a given period of time. The most important point of this problem is