

**UNIVERSITI TEKNOLOGI MARA**

**DEVELOPMENT OF OFFICE  
BUILDING RENTAL PREDICTION  
MODEL BASED ON MACHINE  
LEARNING**

**MUHAMAD HARUSSANI BIN  
ABDUL SALAM**

Thesis submitted in fulfillment  
of the requirements for the degree of  
**Master of Science  
(Built Environment)**

**College of Built Environment**

**December 2022**

## ABSTRACT

Valuers face various challenges in determining property prices and rental values due to their heavy dependence on market data. The use of existing databases in property valuation assignments presents intrinsic challenges where the valuer might derive incorrect assumptions in analysing value-issued comparable data. It is worth noting that when predicting property values and rentals, appraisers and investors cannot rely on historical market data from real estate transactions. With the increasing spectrum of Industrial Revolution 4.0, the introduction of certain computing techniques optimised the advancements in data science technologies are unavoidably the best options. Thus, this research aims to develop the office building rental prediction model based on machine learning. To fulfil this aim, this research proposed three (3) objectives, firstly to identify the factors affecting office building rental based on the statistics from previous empirical study through the systematic literature review. The second objective focuses on the correlation between the factors related and office rental. It commenced with the descriptive analysis performed with the datasets collected from the Valuation and Services Department on office building rental transactions from 2015 to 2021 (6 years) focusing on the Bandar Kuala Lumpur area. In addition, to analyse the relationship between the factors affecting office rentals, empirical experiments were performed through the Shapiro-Wilk and Spearman Correlation analysis. This research developed the office building rental prediction based on machine learning as the third objective. Four (4) algorithms have been assessed namely the Random Forest, Decision Tree, Support Vector Machine and Linear Regression. The model was developed by employing optimal configuration from the Auto Model and tested using two (2) different approaches namely the Split data and Cross-Validation. An in-depth analysis was performed by experimenting with these approaches based on the regression performances of  $R^2$  and Root Mean Square Error. The findings of this research have provided new insights on the 21 factors that could affect office building rental from the macroeconomic, physical, locational, certification and lease details aspect. In addition, the results from the four (4) algorithms that were tested show that Random Forest outperforms other algorithms by acquiring a significant value of  $R^2$  and Root Mean Square Error to predict office rentals. With the application of machine learning aligned with Industrial 4.0, this research would be advantageous to valuers in evaluating office rental values in a more efficient way.

**Keywords:** Office Building, Rental, Prediction, Machine Learning

## ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my Master and for completing this long and challenging journey successfully. The greatest gratitude and thanks go to my supervisor Assoc Prof Sr Dr Thuraiya Mohd, and co-supervisor Associate Professor Dr Suraya Masrom.

My appreciation goes to the staff of Jabatan Penilaian dan Perkhidmatan Harta (JPPH), especially Mr. Azriruddin for providing me with the required data and information pertaining the office building rental markets for my analysis.

I would like to thank the IPSIS Department as Master Organisations, University of Technology MARA, for providing the facilities and equipment to finish this thesis. Special thanks to my colleagues and friends for their help, support, interest, and valuable hints for my research.

Finally, this thesis is dedicated to my loving dear mother, siblings and my best friends Nur Hafizah Putri and Mohd Affif for the consecutive supports throughout my Master journey. This piece of victory is dedicated to all of you. Alhamdulillah.

# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>ii</b>
<b>AUTHOR'S DECLARATION</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ACKNOWLEDGEMENT</b>	<b>v</b>
<b>TABLE OF CONTENTS</b>	<b>vi</b>
<b>LIST OF TABLES</b>	<b>xii</b>
<b>LIST OF FIGURES</b>	<b>xiv</b>
<b>LIST OF SYMBOLS</b>	<b>xvi</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xvii</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Introduction	1
1.2 Research Background	1
1.3 Problem Statement	4
1.4 Research Aims, Questions and Objectives	6
1.5 Scope of research	7
1.5.1 Research area	7
1.5.2 Types of building – office building	7
1.5.3 Main sources of data collection	8
1.6 Significance of the research	8
1.6.1 Significance for industry practice	8
1.6.2 Academic significance	10
1.7 Research methodology	10
1.7.1 Research design	10
1.8 Structure of thesis	14
1.8.1 Chapter 1	14
1.8.2 Chapter 2	14
1.8.3 Chapter 3	14
1.8.4 Chapter 4	15

1.8.5	Chapter 5	15
1.8.6	Chapter 6	15
1.9	Summary of chapter	16
<b>CHAPTER TWO: LITERATURE REVIEW</b>		<b>17</b>
2.1	Introduction	17
2.2	Office building	17
2.2.1	Definition	17
2.2.2	Types of office building	18
2.2.3	Innovation of office building	18
2.3	Price and value in real estate	19
2.4	Theories of rental	20
2.5	Market rental	21
2.6	Office market in Malaysia	22
2.7	Office market in state of Kuala Lumpur	23
2.8	Valuation approach for office building assessment	25
2.9	Traditional approach	26
2.9.1	Comparison method	26
2.9.2	Income approach	27
2.10	Advanced approach	29
2.10.1	Artificial neural network (Ann)	29
2.10.2	Hedonic pricing	30
2.10.3	Spatial analysis	30
2.11	Factors identification	31
2.11.1	Systematic literature review	31
2.11.2	Literature identifications (Step 1)	31
2.11.3	Literature screening (Step 2)	32
2.11.4	Eligibility and exclusion (Step 3)	32
2.11.5	Review on the factors affecting office building rentals	33
2.12	Macroeconomics factors	37
2.12.1	Employment rate	38
2.12.2	Inflation	38
2.12.3	Gross domestic product (GDP)	39
2.12.4	Finance, insurance and real estate (FIRE)	39