UNIVERSITI TEKNOLOGI MARA

# AIR CONDITIONING AND MECHANICAL VENTILATION (ACMV) SYSTEM COST ESTIMATION USING BUILDING INFORMATION MODELING (BIM)

MUHAMMAD DZULFARHI BIN AHMAD

MSc

February 2021

# AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

| | | |
|---|---|---|
| Name of Student | : | Muhammad Dzulfarhi Bin Ahmad |
| Student I.D. No. | : | 2019851242 |
| Programme | : | Master of Science (Mechanical Engineering) – EM703 |
| Faculty | : | Mechanical Engineering |
| Dissertation Title | : | Air-Conditioning and Mechanical Ventilation (ACMV) system cost estimation using Building Information Modeling (BIM) |
| Signature of Student | : | …….. |
| Date | : | February 2021 |

# ABSTRACT

Lately, the construction industry has seen a shift toward Building Information Modeling (BIM) and BIM-based quantity takeoffs (QTO). BIM is quickly turning into a well-known established collaboration process in the construction industry. Moreover, detection of clash and clash analysis during the design phase can reduce time and construction cost. This thesis presents a framework to conduct a QTO and cost estimation within the BIM environment compared to the Traditional Method (2D) for Air-Conditioning and Mechanical Ventilation system with the software interoperability. A research via survey was conducted with clients, consultants, and contractors to respond a few questions about cost estimation and BIM. Autodesk Naviswork is used to detect any clash between ACMV vs ACMV, especially in the area where big size of ducting were used, such as the basement, ground and lower ground floor. BIM 360 are used in this thesis for the purpose of sharing information with others. The result showed that by using BIM-based QTO, less items were needed compared to the traditional method. Difference in time spent for cost estimation is 120 minutes. While for the quantity, it also shows that the total difference for the area of ducting is 1.85% while the length of refrigerant pipe has a difference up to 23.58%. Clash detective features in Naviswork also detect some of the clashes and come out with the clash report. BIM 360 acts as a server and user can review the model without downloading it. Last but not least, from this research it is evident that BIM QTO method can reduce the time spent as well as quantity due to coordination.

# ACKNOWLEDGEMENT

Alhamdulillah, in the name of Allah I have done my research about "Air Conditioning and Mechanical Ventilation (ACMV) System Cost Estimation using Building Information Model (BIM)".

I would like to express my sincere gratitude to Dr. Azli Abd Razak and Dr. Fairuz Rameli for his benevolent guidance and worthy suggestion during the course of this thesis. The valuable research experiences gained during the completion of this thesis would not have been possible without his encouragement and support. The technical discussions with him were very insightful and I will always be indebted to his knowledge.

I would like to thank the faculty and staffs of UiTM for helping me to develop the inclination towards research. I would also like to thank my colleagues for extending their help and sharing knowledge in this field of study. Last but not least, I would like to express my sincere gratitude to my family for all their support and presence at times when I needed it the most.

# TABLE OF CONTENTS


| | | Pages |
|---|---|---|
| **CONFIRMATION BY PANEL OF EXAMINERS** | | **ii** |
| **AUTHOR'S DECLARATION** | | **iii** |
| **ABSTRACT** | | **iv** |
| **ACKNOWLEDGEMENT** | | **v** |
| **LIST OF TABLES** | | **ix** |
| **LIST OF FIGURES** | | **x** |
| **LIST OF ABBREVIATIONS** | | **xiii** |
| **CHAPTER ONE: INTRODUCTION** | | **1** |
| 1.1 | Research Background | 1 |
| 1.2 | Problem Statement | 3 |
| 1.3 | Research Question | 4 |
| 1.4 | Objective | 4 |
| 1.5 | Scope of research | 5 |
| 1.6 | Significance of Research | 5 |
| 1.7 | Research Framework | 6 |
| **CHAPTER TWO: LITERATURE REVIEW** | | 7 |
| 2.1 | Introduction | 7 |
| | 2.1.1 Building Information Modeling (BIM) | 7 |
| | 2.1.2 Virtual Design and Construction (VDC) | 11 |
| | 2.1.3 Mechanical, Electrical and Plumbing (MEP) & Air-Conditioning and Mechanical Ventilation (ACMV) | 12 |
| | 2.1.4 Survey | 16 |
| 2.2 | Construction Cost Estimation | 16 |
| | 2.2.1 Cost Estimate Uses | 17 |
| | 2.2.2 Traditional Cost Estimating Method | 18 |
| | 2.2.3 BIM QTO system | 20 |
| 2.3 | Construction Contracts | 22 |
| | 2.3.1 Delivery Methods & Cost Estimation | 22 |
| 2.4 | Complications in BIM for Model-Based Cost Estimation | 25 |
| | 2.4.1 Model Element | 25 |
| | 2.4.2 Model Level of Development | 27 |
| 2.5 | Costs External to the Model Elements | 29 |