

UNIVERSITI TEKNOLOGI MARA

**AN URBAN MATERIAL FLOW ANALYSIS AND
CARBON FOOTPRINT ASSESSMENT OF
PENANG CITY**

IZYAN MUNIRAH BINTI ABDUL RAHIM

Project submitted in fulfilment of the requirement for the degree of
Bachelor in Environmental Health and Safety
(Hons.)

Faculty of Health Sciences

February 2023

ACKNOWLEDGMENT

In the name of Allah, The Most Gracious, The Most Merciful

Assalamualaikum and Alhamdulillah, all praise to Allah S.W.T The Supreme Lord of the Universe. Peace and blessing to Nabi Muhammad SAW., all prophets and their families. I praise Allah S.W.T for the strength and His blessings in completing my thesis write up.

Thousands of thanks to my parents Mr Abdul Rahim bin Ali and for always being there whenever I need them through out this thesis write up journey. My deepest gratitude and appreciation to my dearest supervisor, Prof. Madya Dr Farah Ayuni binti Shafie for always sharing her thought and opinion from the first untill the end of my research journey. Not to forget, I would like to thank all the lecturers in Department of Environmental Health and Safety, Faculty of Health Sciences who always share their knowledge and advice with me throughout my study in UiTM Puncak Alam. Only God can reward all of you with goodness.

My sincere thanks and appreciation go to all the staff from the department and laboratory who gave their full cooperation and assisted me in many ways throughout my study. A special thanks to my friends from HS243 who always give me support and motivation while completing my study. Lastly, I would like to thank everyone who involved directly and indirectly in this study. Thank you.

TABLE OF CONTENTS

TITLE PAGE	
DECLARATION BY STUDENT	vii
INTELLECTUAL PROPERTIES	vii
APPROVAL BY SUPERVISOR	vii
ACKNOWLEDGMENT	vii
TABLE OF CONTENT	vii
LIST OF TABLES	vii
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS	vii
ABSTRACT	vii
ABSTRAK	vii
CHAPTER 1: INTRODUCTION	1
1.1 Background of study	1
1.2 Problem Statement	2
1.3 Research Objective	3
1.3.1 General Objective	3
1.3.2 Specific Objective	3
1.4 Research Question	3
1.5 Scope and limitation	3
1.6 Significant of Study	4
Chapter 2: LITERATURE REVIEW	5
2.0 Background	5
2.1 The concept of urban metabolism	5
2.2 Importance of urban metabolism study sustainable resources	7
2.3 The impact of urbanization to the area involved	8
2.4 Importance of the MFA for sustainability development	10
2.5 Carbon emission in the urbanization area	11
2.6 Impact of carbon footprint to the environment	14

ABSTRACT

The city has expanded enormously and chaotically, not only in size and density but also in numerous interactions with complexity. Penang City is one of the urbanized cities in Malaysia with a high density of population in it. This urbanization in the city has impact on the environment especially when it involved the energy and resources consumption such as food, water and electricity. These three main energies are important for human being in daily life. However, the over use of the energies could be a threat to the human since it can be used up one day. A high consumption of energy also could produce a high production of waste that could leave impact to the environment. A Material Flow Analysis has been done in this city and this study found that the flow is unstable for several reasons. The food waste is higher than the food consumption as well as the wastewater. However, the carbon emission from the electricity consumption is higher than the input. The reading of carbon footprint from the water and electricity consumption are also high, 289.64 kgCO₂e/day and 462.85 kgCO₂e/day respectively. The findings in this study shows that the uncontrolled of energy consumption and production of waste could leave a huge impact to the environment. Thus, this study could help in obtaining a good mitigation measure in order to reduce the carbon footprint impact on the environment.

Keywords: *urbanization, Material Flow Analysis, carbon footprint, energy consumption, waste produced*

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The city has expanded enormously and chaotically, not only in size and density but also in numerous interactions with complexity and the global adoption of circular economy tactics. Cities offer a lot of opportunity and challenge, but there are numerous factors that contribute to their complexity. Social and power structure, domination, pollution, economic scale, technological progress and evolution are the reasons why complexity exists (Cui et al., 2018; Cui et al., 2019). Urbanization produces population variations and brings about economic, ecological, and social changes in the broadest sense. (Decker et al., 2002; Kennedy et al., 2007; Dinares, 2014; Zorpas et al., 2017).

According to He et al. (2017), Chen and Zhao (2019), Fan and Fang (2020), urbanization affects the consumption of raw materials and value chains, interacts with energy and water consumption, causes massive pollution (CO₂, NO_x, etc.) and damages heritage (Zorpas and Skouroupatis, 2016). It also alters the metabolism of the area. Urban metabolism (UM) comes from biology and it is widely used to explain the interaction and circulation of matter and energy between the interior of a city and the environment (Díaz-Alvarez et al., 2014). Decker et al. (2000) stated that the material input of this urban metabolism study is the energy used, the building, the infrastructure, and various types of waste. Due to the inhabitations of humans and other flora and fauna in cities, individual organisms are not the only ones involved in the operation of cities.

Urban ecosystem research is now widely acknowledged, and sustainable urban planning aims to follow the principles that control how natural ecosystems work. In other words, it is anticipated that cities will be as self-sufficient as ecological systems. Feedback is received, for example, through a scavenger cycle. Scavenger cycle is involving organisms that mainly consume rotten biomass, such as meat and rotten