

**ZERO WASTE CAMPUS: A FRAMEWORK AND
DIGITAL LEARNING MODULE FOR
SUSTAINABLE ENVIRONMENTAL PRACTICES
IN HIGHER EDUCATION INSTITUTION**

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AND DIGITAL LEARNING MODULE FOR
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IN HIGHER EDUCATION INSTITUTION**

by

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**Thesis submitted in fulfilment of the requirements
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LIST OF ABBREVIATIONS

3R	Reduce, Reuse, Recycle
5R	Reduce, Refuse, Reuse, Repurpose, Recycle
7R	Rethink, Refuse, Reduce, Reuse, Repair, Recycle, and Rot
CFA	Confirmatory Factor Analysis
CGSS	Centre for Global Sustainability Studies
EFA	Exploratory Factor Analysis
FGD	Focus Group Discussion
IDI	In-Depth Interview
ISW	Institutional Solid Waste
KAP	Knowledge- Attitude-Practice
KAPVT	Knowledge, Attitudes, Practices, Values, and Technology
MSW	Municipal Solid Waste
PEB	Pro-Environmental Behaviour
SDG	Sustainable Development Goals
SEM	Structural Equation Modelling
SPSS	Statistical Package for the Social Sciences
SWM	Solid Waste Management
TPB	Theory of Planned Behaviour
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UPM	Universiti Putra Malaysia
USM	Universiti Sains Malaysia
UTM	Universiti Teknologi Malaysia
VBN	Value-Belief-Norm Theory
ZWC	Zero-Waste Campus

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**KAMPUS SISA SIFAR: RANGKA KERJA DAN MODUL
PEMBELAJARAN DIGITAL UNTUK AMALAN ALAM SEKITAR LESTARI
DI INSTITUSI PENGAJIAN TINGGI**

ABSTRAK

Peningkatan populasi dan taraf hidup global telah menyebabkan peningkatan pengeluaran sisa, satu isu ketara di universiti-universiti Malaysia di mana kaedah pengurusan sisa seperti kitar semula dan guna semula adalah tidak mencukupi. Berpandukan metodologi Saunders Research Onion, kajian ini meneliti kesedaran dan penyertaan komuniti universiti Malaysia dalam inisiatif sifar sisa yang menekankan pencegahan sisa. Menggunakan pendekatan kaedah campuran melibatkan perbincangan kumpulan fokus dan temu bual mendalam, kajian ini mengenal pasti sepuluh faktor utama yang mempengaruhi Tingkah Laku Pro-Alam Sekitar (PEB): pengalaman peribadi dalam pengurusan sisa, pendidikan alam sekitar, teknologi sosial, tanggungjawab sosial, kesedaran diri, kontingensi pengukuhan, polisi, kepimpinan teladan, penglibatan komuniti, dan matlamat alam sekitar. Faktor-faktor ini disintesis ke dalam kerangka teori yang mengintegrasikan adaptasi Kerangka Teori Pengetahuan, Sikap, Amalan, Nilai, dan Teknologi (KAPVT) dengan Model PEB Kollmuss dan Agyeman, Teori Tingkah Laku Terancang, dan Teori Nilai-Kepercayaan-Norma/ Pemodelan Persamaan Struktur - Analisis Faktor Pengesahan mengesahkan hubungan dalam kerangka ini menggunakan data tinjauan daripada 393 responden dari tiga universiti Malaysia. Penemuan menunjukkan korelasi positif yang signifikan membawa kepada penciptaan Modul Pembelajaran Digital Kampus Sisa Sifar untuk mempromosikan amalan lestari. Ini menyediakan asas kukuh untuk meningkatkan strategi pengurangan sisa peringkat nasional dan memajukan kemampanan kampus.

**ZERO WASTE CAMPUS: A FRAMEWORK AND DIGITAL LEARNING
MODULE FOR SUSTAINABLE ENVIRONMENTAL PRACTICES IN
HIGHER EDUCATION INSTITUTION**

ABSTRACT

The global rise in population and living standards has led to increased waste production, a significant issue in Malaysian universities where existing waste management methods such as recycling and reusing are inadequate. Guided by Saunders Research Onion methodology, this study examines the awareness and participation of Malaysian university communities in zero-waste initiatives focused on waste prevention. Utilizing a mixed-method approach with focus group discussions and in-depth interviews, the research identified ten key factors influencing Pro-Environmental Behaviour: personal experiences, environmental education, social technology, social responsibility, self-awareness, reinforcement contingencies, policy, leadership, community engagement, and environmental goals. These factors were synthesized into a framework that integrates an adapted Knowledge, Attitudes, Practices, Values, and Technology (KAPVT) theoretical framework with Kollmuss and Agyeman's PEB Model, Theory of Planned Behavior, and Value-Belief-Norm Theory, providing a comprehensive view of PEB. Structural Equation Modelling - Confirmatory Factor Analysis validated the relationships within this expanded framework using survey data from 393 respondents across three Malaysian universities. The findings demonstrated significant positive correlations between factors, leading to the creation of a digital Zero-Waste Campus Learning Module to promote sustainable practices. This provides a robust framework for enhancing national waste reduction strategies and advancing campus sustainability.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Solid waste management (SWM) remains a major societal and governance challenge, particularly in urban areas that are overwhelmed by rapid population growth and increasing waste generation (Abubakar et al., 2022). Changes in urban lifestyles have resulted in a severe Municipal Solid Waste (MSW) problem. The rate of waste generation has surged alongside the rate of urbanization (Hoornweg & Bhada-Tata, 2012). Human activities continuously generate waste across various sectors, including industry, construction, commerce, services, and residential areas (Yang et al., 2018).

Annual waste generation is projected to increase by 73% from 2020 to reach 3.88 billion tonnes by 2050, driven by rapid population growth and urbanization. Residents in developing countries, particularly the urban poor, are expected to be more severely impacted by unsustainable waste management practices compared to those in developed countries (World Bank Group, 2022), making waste collection and landfill management increasingly challenging (Kaza et al., 2018).

According to the Malaysian Investment Development Authority (MIDA, 2021), Malaysia's growing population of 32.8 million in 2021 generates a substantial amount of solid waste, estimated at 38,427 metric tonnes per day (1.17 kg per capita per day), with 82.5% of this waste being disposed of in landfills. The Department of Statistics Malaysia (DOSM, 2022) reported that Malaysia's population increased by 0.3% in the third quarter of 2022, reaching 32.9 million. This increase is expected to affect the total amount of MSW collected, following the trends established in the previous year. Additionally, it has been reported that more than 200,000 tonnes of MSW have been

generated monthly since the implementation of the first Movement Control Order (MCO) from March 2020 to March 2021, with food and plastic waste being the primary contributors to landfills (Rahimy, 2021).

The Ministry of Housing and Local Government in Malaysia established the Department of National Solid Waste Management (Jabatan Pengurusan Sisa Pepejal Negara - JPSPN) to standardize and enhance waste management practices (Sreenivasan et al., 2012). The formation of JPSPN represents a significant step towards achieving the National Green Agenda's recycling rate target of 40% by 2025. JPSPN is tasked with overseeing solid waste management under Act 672 of 2007, which pertains to Solid Waste Management and Public Cleansing. This act has been in effect since 1 September 2011 (MIDA, 2021). Despite these efforts, challenges such as limited funding, insufficient technical capacity among staff, and ambiguities in policy guidelines have persisted (Kaza et al., 2018). Additionally, the act has only been implemented in the Federal Territories of Kuala Lumpur and Putrajaya, as well as in the states of Pahang, Negeri Sembilan, Melaka, Johor, Kedah, and Perlis. In other states of Malaysia, including Perak, Pulau Pinang, Kelantan, Selangor, Sabah, and Sarawak, waste management responsibilities remain under the purview of the respective State Governments.

In addition to these challenges, the MSW problem is among the many environmental issues influencing human behaviour (Gardner & Stern, 1996; Koger & Winter, 2010). Vlek and Steg (2007) note that environmental quality is significantly affected by human behaviour patterns, and altering these behaviours may mitigate environmental impacts. In Malaysia, food waste constitutes 32% of total waste, with plastic waste accounting for 21% and other plastics for 14% (Ramli et al., 2022). Daily,

approximately 17,000 tonnes of food waste are generated, of which 4,005 tonnes, or 24%, are still edible or easily avoidable (Hani, 2022). This food waste is discarded and added to already overburdened landfills, underscoring the importance of preventing food waste at the consumer level.

Thus, changes in human behaviour are believed to be crucial for addressing the waste problem. Promoting behaviour change is most effective when it is systematically planned, implemented, and evaluated (Geller et al., 1982). Consequently, environmental education is essential for fostering positive environmental attitudes (Michelsen & Fischer, 2018). The goal of environmental education is to develop an environmentally conscious society equipped with the knowledge, skills, attitudes, motivations, and commitment necessary to address current issues and prevent future problems (UNESCO-UNEP, 1976).

As global awareness grows, there is increasing interest in addressing global waste issues through innovative concepts and philosophies such as zero-waste and the circular economy (Zaman, 2022). The zero-waste concept, a recent addition to sustainability frameworks, challenges the prevailing view of waste as a worthless and unavoidable by-product produced at the end of a product's life cycle. Instead, zero-waste views waste as a "misallocated resource" or "resource in transition" that is generated during intermediate stages of production and consumption (Zaman & Newman, 2021). Despite the potential benefits of these approaches, the zero-waste concept has not yet been officially adopted by the government. However, some non-governmental organizations (NGOs) have begun advocating for the movement. It is noteworthy that the government has initiated efforts to reduce single-use plastics and promote sustainable waste management practices.

In this complex context, university campuses play a crucial role in addressing these challenges. Campuses hold significant potential to engage in pro-environmental behaviour (PEB) through educational initiatives, aligning with the principles of sustainable campus operations and Education for Sustainable Development (ESD). The innovative "living lab" model, adopted by Malaysian universities such as Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), Universiti Malaya (UM), and Universiti Teknologi Malaysia (UTM), exemplifies the integration of users, academia, and practical applications within an ecosystem of open innovation (da Silva et al., 2018). In this framework, the "Zero Waste Campus" movement gains traction, focusing on waste reduction, increased awareness, and alignment with waste hierarchy principles. These initiatives extend beyond campus boundaries, forming partnerships with local stakeholders to drive broader societal change and contribute to a more sustainable future.

This research is anchored in a robust theoretical framework that draws upon established theories such as the Knowledge-Attitude-Practice (KAP) models, the Theory of Planned Behavior (TPB), the Value Belief-Norm Theory (VBN), and Kollmuss and Agyeman's Model of Pro-Environmental Behavior (PEB). These theories have been employed in prior studies to elucidate the various factors influencing PEB within university campuses. The selected theories inform the development of precise research questions and hypotheses, assist in designing surveys that encompass a broad range of factors, and provide a systematic approach for data analysis. This theoretical alignment enhances the academic rigour of the research, ensuring that the findings are both insightful and methodologically sound, and firmly situated within the existing scholarly discourse.

1.2 Problem Statement

In the specific context of waste management practices in Malaysia, despite government campaigns promoting the adoption of the 3Rs (reduce, reuse, and recycle) since the 1990s, the recycling rate in 2021 was 31.52%, notably lower than the rates observed in most developed countries, which exceed 60% (Tan et al., 2022). Although there was an increase to 33.17% in 2022 (The Malaysian Insight, 2022), this rate remains relatively low. The limited adoption of recycling practices in Malaysia results in an annual loss of approximately RM476 million in recyclable resources, primarily due to the population's insufficient awareness of the significant commodity value of their waste, as reflected by the country's low recycling rate (Rosni et al., 2022). Achieving the target of a 40% recycling rate by 2050 is challenging given the slow rate of increase.

According to Moh and Abd Manaf (2017), the primary barrier to effective waste separation at source is the public's attitude towards making it a habitual practice. Despite the Malaysian government's introduction of a mandatory waste separation program for households in Kuala Lumpur on 1st September 2015, as part of its national waste separation at source initiative (SwCorp, 2016), a one-year grace period has proven insufficient to raise awareness and effectively promote the program. Although numerous campaigns and enforcement efforts have been undertaken, the Separation at Source Initiative (SSI) has seen limited success, with only 10% of households in high-rise buildings practising waste separation at the source in 2019, according to SwCorp data (Razi et al., 2022). Furthermore, Act 672 stipulates penalties for households that fail to comply with waste separation requirements, with initial fines set at RM50 for

landed properties and RM100 for premises such as shop lots, as of 2018. However, this policy has yet to be enforced (Razi et al., 2022).

Several universities worldwide, including those in Malaysia, have undertaken various initiatives aimed at creating sustainable campuses (Ruzaimah, 2017). However, these efforts are often not applied systematically. The effectiveness of sustainability initiatives on campuses is linked to integrative and transformative approaches, which must address issues in alignment with the initiatives, recognizing the dynamic balance between humans and the environment as crucial for establishing a sustainable campus (Zen et al., 2016). Thus, for sustainability initiatives in public universities, the dynamic relationship between the community and the campus is essential for ensuring the success of the programs.

A study conducted by Syed Azhar et al. (2022) on the attitudes and perceptions of 513 USM undergraduate students towards sustainability revealed that while 87.7% of respondents are familiar with the term, a significant portion are unaware of USM's Policy on Sustainability (33.1%) and the campus's sustainability-related programs (28.5%). This suggests that despite well-planned programs, there may be low levels of participation from the campus community (Ridzuan et al., 2012).

Furthermore, Malaysian universities are reported to significantly contribute to solid waste generation in the country (Abas, 2018). Therefore, addressing the waste problem at universities is believed to be most effectively achieved through education that explores the campus community's knowledge, attitudes, practices, and values concerning waste management.

This study investigates the factors influencing PEB among the USM campus community in relation to the zero-waste initiative. It specifically examines waste management practices, including source waste minimization, recycling practices, and other strategies aligned with the zero-waste hierarchy. A theoretical framework for a zero-waste campus will be developed to address the factors influencing PEB. This framework is intended to guide and promote the adoption of sustainable practices on campus. Additionally, a learning module will be created to integrate the identified factors and theoretical framework, aiming to foster sustainable practices and behaviours among the campus community. The research findings are expected to contribute to sustainability efforts and provide insights that inspire positive change within the USM campus community regarding the zero-waste initiative. Moreover, the developed framework and learning module may serve as valuable resources for other universities or organizations seeking to advance sustainability and zero-waste practices.

1.3 Scope of the Study

One of the main limitations of this study is the use of respondents from only three research universities in Malaysia: USM, UKM, and UPM. Although purposeful sampling was employed to select information-rich cases, this non-probabilistic method constrains the generalizability of the findings to other universities within Malaysia or in different countries. The study would have benefited from a more extensive and diverse sample, incorporating universities with varying characteristics, such as size and location.

Another limitation is that the digital learning module developed for the study was a prototype rather than a fully implemented application. While the prototype aimed to enhance waste management practices on university campuses in Malaysia, its effectiveness could not be thoroughly evaluated. A more rigorous assessment of the module's impact would necessitate a larger sample size and a more extended observation period to accurately measure its influence on behaviour change within the university community.

Overall, while this study provides valuable insights into the factors influencing waste management practices on university campuses in Malaysia, its limitations should be considered when interpreting the findings and applying them to other contexts.

1.4 The Significance of the Study

This study aims to propose a framework to promote environmental sustainability through PEB, particularly in the context of a Zero Waste Campus. The framework will serve as a foundation for developing a comprehensive and practical educational module.

1.4.1 Theoretical Implication

This study holds significant theoretical implications for environmental sustainability and PEB. The proposed zero-waste campus framework and educational module contribute to the theoretical understanding of fostering environmentally sustainable behaviour, particularly within educational institutions. Additionally, the study can inform future research on environmental education and behaviour change. Furthermore, this research offers a more comprehensive and integrated approach to achieving zero waste, which may be applicable to other sectors.

1.4.2 Practical Implication

This study has practical implications for various stakeholders, including educational institutions, policymakers, waste management authorities, and the public. Educational institutions can utilize the proposed zero-waste campus framework and educational module to develop and implement effective programs that promote PEB among students, staff, and faculty members. Policymakers and waste management authorities can leverage the framework to formulate strategies and policies that enhance public awareness and participation in waste minimization efforts, aiming towards zero waste. The public can benefit from the framework as it offers practical guidelines for adopting and promoting PEB in their daily lives. Consequently, the proposed framework has significant practical implications, contributing to the achievement of zero waste at the national level and ultimately benefiting societal well-being.

1.5 Research Objectives

This research aims to identify the factors influencing communities' participation in sustainable waste management, including waste minimisation at source, recycling, and waste segregation. At the same time, the study also aims to propose a framework for an educational module to shape the PEB towards the Zero Waste Campus goal. The following specific objectives have been outlined to achieve the set aims:

- i. To investigate the main factors that influence the PEB towards Zero-Waste Campus.
- ii. To determine the relevant factors in shaping the community's sustainable PEB towards Zero-Waste Campus.
- iii. To develop a framework to help promote environmental sustainability via sustainable PEB towards Zero-Waste Campus.
- iv. To develop an educational module in enhancing campus community awareness and participation in sustainable waste management towards Zero-Waste Campus.

1.6 Research Question

This study embarks on investigating the following research questions:

- i. What are the main factors that influence the PEB towards Zero-Waste Campus?
- ii. What are the relevant factors shaping community participation in sustainable waste management towards Zero-Waste Campus?
- iii. What is the suitable framework for an educational module to help promote environmental sustainability via PEB towards Zero Waste Campus?
- iv. What is the suitable educational module in enhancing campus community participation in sustainable waste management towards Zero Waste Campus?

1.7 Research Hypothesis

This study explores the relationships among various constructs and variables within the context of public university campus communities. The primary elements of the study are defined as follows:

- i. Context: Public university campus communities, which provide the setting for this research.
- ii. The independent variable: These include knowledge, attitudes, practices, and values held by the community, which are hypothesized to impact PEB.
- iii. Dependent variables: PEBs related to zero-waste, including waste minimization, recycling, and separation practices, which are the outcomes influenced by the independent variables.
- iv. Confounding Variable: Technology, which may influence or obscure the relationships between the independent and dependent variables.
- v. Possible relationship: The study investigates how the independent variables (knowledge, attitudes, practices, and values) affect the dependent variables (PEBs) and examines the role of technology as a potential confounding factor.

Figure 1.1 illustrates the graphical representation of these relationships, depicting how the variables interact within the framework of this research.

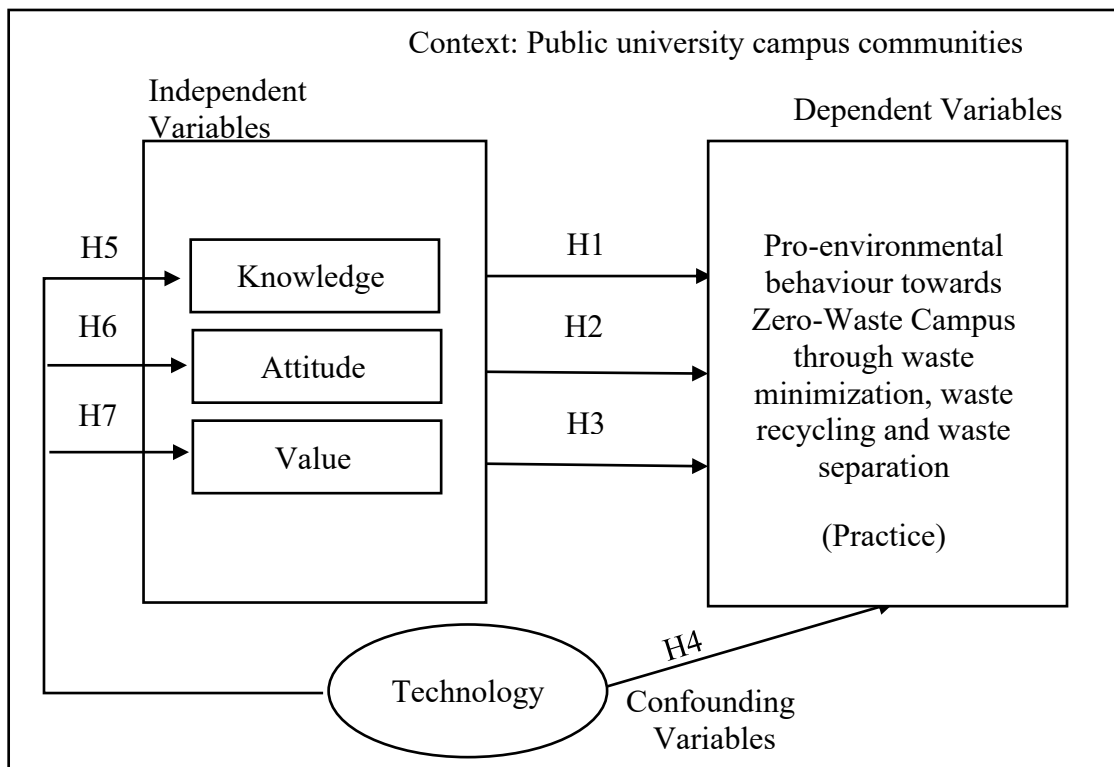


Figure 1.1 Relationship Between Variables

Based on the initial graphical representation, several models will be proposed to serve as the framework for a zero-waste campus. Table 1.1 presents the proposed hypotheses for the study.

Table 1.1 Thesis Formatting with MS Word training sessions

Hypothesis	Description
H1: Knowledge has a positive effect on PEB practice.	Increased knowledge of zero-waste practices is expected to significantly enhance PEB, including waste minimization and recycling.
H2: Attitude has a positive effect on PEB practice.	Positive attitudes towards environmental sustainability are anticipated to improve engagement in PEB.
H3: Value has a positive effect on PEB practice.	Stronger environmental values are likely to lead to more consistent PEB, supporting effective waste management practices.
H4: Technology has a positive effect on PEB practice.	Technology's positive influence on waste management practices is expected to facilitate better waste minimization and recycling efforts.
H5: Technology has a positive effect on knowledge.	The use of technology is anticipated to enhance knowledge of zero-waste practices, which is essential for promoting effective waste reduction and recycling behaviors.
H6: Technology has a positive effect on attitude.	Technology is expected to positively impact attitudes towards zero-waste practices, thereby improving participation in sustainable waste management efforts.
H7: Technology has a positive effect on value.	Technology is projected to influence environmental values, contributing to stronger commitment to zero-waste practices.

1.8 Operational Definition

i. Pro-Environmental Behaviour (PEB)

PEB is defined as intentional actions taken to minimize negative impacts on the environment and to contribute positively to environmental preservation (A. K. Kim et al., 2021; Steg & Vlek, 2009; Q. Wang et al., 2022). This behaviour encompasses activities aimed at protecting both natural and built environments and promoting sustainability (Choon, 2024; Vinojini & Arulrajah, 2017). It involves conscious efforts to reduce environmental harm and support societal protection for environmental conservation (Aziz et al., 2018; Ifegbesan et al., 2022). In the context of this study, PEB specifically focuses on university campus community participation in waste minimization efforts towards achieving a Zero Waste Campus.

ii. Sustainable waste management

Sustainable waste management involves a systematic and integrated approach aimed at minimizing the environmental impact of waste generation, disposal, and treatment. This approach seeks to maximize resource efficiency and promote sustainable development (Gunasekaran et al., 2014). It includes various strategies and techniques such as waste prevention, recycling, and proper disposal to support economic and environmental objectives (de Delmônico et al., 2017). Additionally, sustainable waste management emphasizes governance aspects, including the inclusivity of users and service providers, financial sustainability, and the role of coherent institutions supported by proactive policies (D. C. Wilson et al., 2013). It also involves the implementation of effective waste collection systems that align with the Sustainable Development Goals (Pires et al., 2019).

iii. Waste minimisation

Waste minimization is a systematic process aimed at reducing waste generation at its source. This approach involves strategies such as source reduction, waste segregation, and the use of recyclable materials to decrease the volume of waste produced, enhance waste quality, and promote recycling and reuse (Alotaibi, 2024; Othman et al., 2020). By integrating these strategies into project design and implementation, waste minimization seeks to minimize environmental impact and improve operational efficiency (Dainty & Brooke, 2004; Jahan et al., 2022; Singh et al., 2015).

iv. Recycling

Recycling is defined as the process of preserving or recovering the distinct characteristics of materials through the recycling chain to maximize their potential for reuse within a circular economy (Grant et al., 2023). It involves ensuring high-quality recycling standards and aligning definitions for accurate measurement of recycling rates (Gazeau, 2024; Faraca et al., 2019). Additionally, recycling is integrated throughout the entire life cycle of materials, including operation and retirement phases, to support sustainability (Li et al., 2023; Aljboor, 2023).

v. Waste Segregation

Waste segregation is the process of sorting waste into categories such as paper, plastic, metal, glass, and biodegradable materials to enhance waste management and support sustainability (Bobulski & Kubanek, 2021; Cui et al., 2023; Sahiledengle, 2019). This practice is crucial for effective waste disposal, reducing the burden on waste treatment facilities, and facilitating recycling and composting (Azis, 2023; Elie, 2023; Elmedulan et al., 2014). In the context of a zero waste campus, waste segregation

involves separating materials to promote recycling and composting, thus contributing to overall sustainability goals (Jia et al., 2006; Nepal et al., 2022).

vi. Community participation

Community participation in the context of a zero waste campus involves the active engagement of campus members in waste reduction and sustainability initiatives. This includes identifying waste management issues, making decisions related to waste practices, and implementing solutions to achieve zero waste goals. Activities encompass attending sustainability meetings, volunteering for waste minimization projects, providing feedback on waste practices, and collaborating to enhance recycling and composting efforts. Effective participation also involves educating peers about sustainable practices and supporting campus-wide waste reduction efforts (Kelly, 2001; Oakley & Marsden, 1987; Safe'i et al., 2022).

vii. Zero Waste

According to the Zero Waste International Alliance (2018), Zero Waste is defined as the conservation of all resources through responsible production, consumption, reuse, and recovery of products, packaging, and materials. This approach excludes burning and prevents any discharges to land, water, or air that could threaten environmental or human health. This study focuses on waste minimization and efforts towards establishing a Zero Waste Campus.

viii. Knowledge

Knowledge refers to the acquisition, retention, and application of information or skills (Badran, 1995). Similar to cognition, it encompasses the process of understanding gained through both formal and informal education. In this study, knowledge pertains specifically to the comprehension of PEB, with a focus on waste minimization and

recycling. This construct involves understanding, cognition, and the perception of information related to the behaviour under investigation.

ix. Attitude

Attitude is defined as a psychological tendency expressed through evaluating a particular entity with varying degrees of favor or disfavor (Eagly & Chaiken, 1993). It reflects a predisposition to respond in certain ways towards the attitude object (Wan et al., 2016). In this study, attitudes refer to individuals' tendencies in situational evaluations related to PEB, particularly concerning waste minimization and recycling. The construct of attitude indirectly assesses responses to specific behaviors.

x. Practice

Practice refers to the demonstration of knowledge and attitudes through actions (Kaliyaperuma, 2004). Unlike attitudes, which are internal dispositions, practice involves observable and concrete actions in response to a stimulus. In this study, practice pertains to the actions taken in response to specific environmental situations related to waste minimization and recycling. This construct addresses an individual's behavioral responses when engaging with particular scenarios associated with the studied behaviour.

xi. Value

Value represents an affective domain of human experience (Kratwohl et al., 1964) and involves the internalization of emotions and feelings. It refers to the acceptance of a phenomenon or behaviour based on its perceived worth, excellence, usefulness, or importance. The human value system supports self-exploration, self-enhancement, and self-recognition. Values are consciously chosen, articulated consequences of ongoing, dynamic patterns of activity, which establish primary motivators for intrinsic engagement in valued behaviors (K. G. Wilson, 2009). In this

study, value pertains to an individual's preference for specific PEB. This construct involves identifying the emotions that influence behaviour.

xii. Technology

Technology refers to the application of scientific knowledge for practical purposes, as defined by the New Oxford American Dictionary (2001). It plays a crucial role in sustainable environmental development, with advancements shaping how people work, network, and communicate (Beder, 1994; Kongoli, 2016). In the context of this study, technology encompasses the strategic use of scientific and technical knowledge to address waste management challenges effectively. It includes the integration of relevant human behaviors and technological solutions to improve waste minimization efforts. Thus, applying technology appropriately is essential for achieving the objectives of this study and advancing sustainability goals.

1.9 Organization of the Thesis

This study is composed of seven chapters. The first chapter serves as an introduction, providing background on managing MSW in Malaysia, with a focus on university campuses. The chapter highlights the importance of the study, discussing both the theoretical and practical implications it may have. The research objectives are clearly specified, alongside the research questions, the scope of the study, and the hypotheses. Additionally, the chapter provides context for the operational definitions used in the study. Finally, the first chapter concludes with a brief overview of the remaining chapters in the study.

Chapter two forms the foundational backbone of this thesis, conducting an extensive exploration of PEB within university campuses. It begins by defining and interpreting PEB, establishing a solid foundation for the study. The chapter examines

sustainable waste management principles, starting with the fundamental 3Rs (reduce, reuse, recycle) and progressing to the more comprehensive 5Rs and 7Rs, as well as the overarching Zero-Waste Initiative framework. Recognizing the critical role universities play in promoting zero-waste practices, the chapter highlights their contributions to sustainability. It analyzes SWM strategies and policies in Malaysia, situating the study within the national context and extends the analysis globally by aligning zero-waste practices with the United Nations Sustainable Development Goals (SDGs), providing a broader perspective on the study's implications.

Chapter two as well introduces key theoretical frameworks, including TPB, VBN, Kollmuss and Agyeman's Model of PEB, and the KAPVT model, which guide the subsequent research phases. Additionally, the chapter emphasizes the importance of employing an exploratory mixed methods approach and introduces the prototyping model for developing an electronic-based educational module using andragogical approaches, adding practical depth to the research. It also discusses Saunders' Research Onion as the methodological framework guiding the study's design and implementation.

The third chapter of this thesis outlines the methodology employed in conducting the research. It adopts Saunders' Research Onion model as a structured framework to guide the research process. This model facilitates a comprehensive understanding of the various stages involved, providing clarity on the research philosophy, theory development approach, research methods, strategy, time horizon, and techniques and procedures utilized in the study. The chapter offers a detailed account of these methodological components, ensuring a transparent description of the research process. By leveraging the Research Onion model, the study establishes a clear and systematic approach to research, thereby enhancing the reliability and validity of

the findings. This chapter encompasses the methodology's various elements, including data collection methods, data analysis techniques, and the development of both the Zero Waste Campus Framework and the educational module.

Chapter four delves into the analysis of both qualitative and quantitative data collected throughout the study. It provides a detailed examination of findings from focus group discussions (FGDs) and in-depth interviews (IDIs), offering insights into factors influencing PEB on university campuses. The chapter also includes a quantitative analysis phase, focusing on descriptive statistics and ensuring the data's validity for statistical testing. Overall, it synthesizes insights from various research methods to deepen the understanding of the factors affecting environmental behaviour in the campus context.

Chapter five focuses on the development and evaluation of a zero-waste campus framework. It begins by presenting the initial proposed framework and assessing its measurement model for reliability and validity. The chapter then refines the framework through a rigorous examination of its goodness of fit and hypothesis testing. Various alternative frameworks are evaluated to determine the most effective model, culminating in the finalization of the USM Zero Waste Campus Framework. Additionally, the chapter investigates the influence of a moderating variable on the framework's performance.

Chapter six centers on the development of an educational module through a structured prototype model. This chapter initiates with an introduction to the module's objectives and goals, followed by a detailed description of the design process, which involves sketching the module's content and structure. The construction of a functional prototype is then described, outlining how it was developed and tested with a sample of

the target audience. User feedback is gathered to refine the prototype, ensuring its effectiveness and relevance. The chapter concludes with the deployment of the final version of the educational module, emphasizing its systematic, iterative development approach to meet educational objectives and address the needs of the target audience effectively.

The final chapter of the study focuses on the conclusion and future recommendations. This chapter summarises the research objectives and answers the research question, highlighting the study's success. The implications of the research, both theoretical and practical, are discussed in this chapter. Additionally, the study's limitations are highlighted, and recommendations for future research are proposed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 provides an in-depth analysis of PEB within the context of university campuses, which is central to this study. The chapter begins by establishing a comprehensive understanding of PEB, examining its various definitions and interpretations to set the foundation for the analysis that follows. It then explores sustainable waste management principles, ranging from the fundamental 3Rs (reduce, reuse, recycle) to the more complex 5Rs and 7Rs, all within the framework of the Zero-Waste Initiative.

The discussion highlights the critical role that universities play in advocating for zero-waste practices and their substantial contributions to achieving broader sustainability objectives. It further addresses the landscape of SWM strategies and policies at both the national and global levels, with a focus on their alignment with the SDGs,

The chapter introduces key theoretical frameworks essential for understanding PEB, including the TPB, VBN, and Kollmuss and Agyeman's Model of PEB. This theoretical groundwork is complemented by an examination of the KAPVT model, offering a comprehensive view of the campus community's engagement with PEB.

Finally, the chapter outlines the methodological approaches employed in this study, including an exploratory mixed-methods approach, the development of educational modules using andragogical principles, and the application of a prototyping model for effective module construction. This introduction lays the groundwork for the

detailed analysis and subsequent chapters, framing the study's approach to addressing PEB in the university context.

2.2 Defining PEB within Zero-Waste Frameworks on University Campuses

PEBs encompass deliberate actions aimed at mitigating the negative impact of human activities on the natural and built environment. Kollmuss and Agyeman (2002) emphasize that these behaviors involve a conscious effort to minimize adverse effects on the environment. Similarly, Steg and Vlek (2009) define PEB as actions intended to reduce one's ecological footprint and promote environmental well-being. Both definitions underscore the importance of intentionality and thoughtful consideration when engaging in activities that benefit the environment.

The realm of PEB is intertwined with various related terms and concepts. Alongside the widely used term "pro-environmental behaviour," a plethora of associated keywords have gained prominence. These terms include sustainability, climate change, sustainable development, environmental attitudes, human protection, and environmental education. These interconnected concepts contribute to a holistic understanding of the multifaceted nature of PEB. Sollberger (2016) presents a diverse array of examples that epitomize PEB. These examples encompass a wide spectrum of actions, such as recycling, reusing products, reducing waste, opting for non-toxic substances, choosing energy-efficient appliances, adopting eco-friendly transportation practices, supporting local and seasonal food choices, regulating energy consumption, and engaging in environmentally conscious political activities. These myriad actions collectively underscore the intricate tapestry of behaviors falling under the PEB umbrella.

Given the heterogeneous nature of PEBs, the need arises for objective indicators that facilitate systematic analysis. Ones et al., (2015) address this by classifying a multitude of specific behaviors into five overarching categories known as the "Green Five." This categorization provides a structured framework to understand the wide-ranging behaviors associated with pro-environmental intentions in this study. The Green Five categories include conserving, avoiding harm, transforming, influencing and taking initiative. Within the context of zero-waste initiatives on university campuses, the Green Five categories of PEB (Ones et al., 2015) are particularly significant, as they align with the objectives of this study to foster sustainable waste management practices among the campus community.

- i. **Conserving:** Within the realm of zero waste, conserving becomes a crucial pillar. This involves not just reusing, recycling, and repurposing, but also minimizing the creation of waste in the first place. By employing practices that preserve resources and reduce waste, the foundation for a zero-waste approach is established.
- ii. **Avoiding Harm:** Zero waste initiatives align perfectly with minimizing harm to the environment. Efforts to prevent pollution, engage in cleanup activities, and ensure responsible stewardship dovetail seamlessly with the goal of generating minimal waste. By avoiding environmental harm, the campus community inherently moves closer to achieving zero waste targets.
- iii. **Transforming:** A fundamental principle of zero waste initiatives involves transformative change. Embracing sustainable practices and eco-friendly technologies is at the heart of this transformation. Adopting innovative solutions that minimize waste and maximize resource utilization is central to the journey toward zero waste.