

CHAPTER I INTRODUCTION

1.1 Project Background

Plastic packaging used by shoppers continues to create serious environmental challenges both in Malaysia and globally. The waste from plastic bags affects the ecosystem increasing pressure on waste management system especially in urban area. (OECD, 2022) observes that, without more decisive action we can expect increases in plastic use, plastic waste and leakage into the environment. This is why the government and local communities are promoting reusable alternatives to single-use plastics. The direction is aligned with Sustainable Development Goal (SDG) 12, as it supports waste reduction through the strategy of prevention by, reduction, recycling, and reuse.

Malaysia has encouraged the use of reusable bags, for example tote bags, in malls, supermarkets, marketplaces, and university areas as a plastic reduction policies. Still, with so many shoppers forgetting their own bags, tote bags are a simple buy at the register. Repeated tote bag purchases adds unnecessary cost, increasing the number of unused bags, thus weaken the purpose of reuse. This reflects an intention behavior gap, consumers may support plastic reduction but still sometimes face practical barriers at the purchase counter. Therefore, a structured borrow-and-return system is needed to provide reusable bags when needed while also encouraging return behaviour, using an organised and trackable workflow.

1.2 Problem Statement

Although the shift toward reusable alternatives is positive, the consistent reuse behaviour still remains difficult in everyday shopping. Consumers, especially students and working adults that has busy schedules, would often arrive at the checkout counter without a reusable bag. In this situation, buying another tote bag becomes the easiest option. Over time, repeated purchases create unnecessary personal costs and contribute to the accumulation of unused tote bags at home. This may weaken the sustainability purpose of reducing plastic bag use.

Recent Malaysian studies have examined plastic bag consumption, willingness to pay, and behavioural intention related to plastic reduction. (Mohamed Noor et al., 2024) research on the behavior on the consumer behaviour on the willingness to pay higher price for biodegradable plastic bags in Bandar Baru Bangi, Selangor, while (Van et al., 2021) using Planned behavior theory, examining the intention to lessen single-use plastics in Malaysia. These studies help explain consumer behaviour and policy response, but they give limited attention to a system-level borrowing-and-return mechanism that provides reusable bags at checkout while recording bag identity, return activity, and simulated deposit accountability. Therefore, this project addresses both a behavioural and infrastructural gap through an integrated kiosk-based workflow for Malaysian retail contexts.

Addressing this issue, a structured system for borrowing and returning bags is needed. This project proposes a proof-of-concept kiosk-based borrowing and return system supported by IoT-enabled identification technologies, using RFID or NFC to record borrowing and return status. A deposit-based system is included to encourage users to return the borrowed bags, allowing the bags to continue circulating instead of being kept indefinitely.

The main issue is the disconnection between sustainability goals and actual consumer behaviour at checkout, where limited infrastructure makes access, return, and reuse difficult. For this reason, this study proposes an IoT-enabled kiosk system with deposit-based incentives to support reusable bag circulation in selected Malaysian retail environments. Based on the identified issues and research gap, the following research questions are formulated:

- a. What key user needs and point-of-purchase challenges should a kiosk-based reusable bag borrowing system address in Malaysian mall and supermarket settings?
- b. How can a kiosk-based borrowing and return system supported by IoT-enabled identification and deposit incentives be designed to provide point-of-need access and encourage responsible returns?

- c. To what extent can the proposed prototype improve return compliance and reduce repeated tote bag purchases in a controlled/simulated evaluation?

1.3 Research Objectives

This study develops and evaluates a proof-of-concept Internet of Things (IoT) kiosk that are used for borrowing and return a reusable shopping bags. Responding to a common scenario where shoppers that who often arrive at check out without a reusable bag, but support plastic reduction, from buying another tote bag, where it creates avoidable cost and undermines the purpose of reducing plastic waste.

This project focuses on providing reusable bags at the point of need while also encouraging their returns through bag identification, with a structured borrow-and-return workflow, and a deposit-based concept. This provides a system-level approach rather than only depending on the individual discipline.

Accordingly, the specific objectives of this study are as follows.

- a. To design and develop an intelligent kiosk system that can dispense and receive reusable grocery bags through automated deposit and refund transactions.
- b. To integrate AI-based tag recognition (e.g., RFID, NFC, or computer vision) to identify and authenticate each reusable bag during return and release operations.
- c. To implement a secure digital payment module that automatically refunds the user's deposit upon verified bag return.
- d. To develop a cloud-based database for tracking bag usage, user history, and return rates in real time, ensuring accountability and data-driven insights.

The objective above presents the full vision of the proposed system of SmartBag Kiosk. They are addressed at a proof-of-concept level. Deposit and refund are simulated as system status, bag identification is implemented using RFID-based tag recognition, database functionality is represented through local dashboard records and transaction logs, and AI remains an AI-ready future enhancement rather than a trained model implemented in the prototype.

1.4 Scope of Study

The project that are registered by the title “Development of AI-Enabled Smart Grocery Bag Deposit and Return Kiosk System for Sustainable Retail Operations” focuses on the implementation of an IoT-enabled kiosk used for borrowing and returning reusable bags. The scoped that are implemented used RFID to identify the bag identity, track bag status, log transactions, and simulate deposit status. No payment gateway is used, and the prototype is evaluated using a single-location return model.

This project focuses on design, development, and evaluation of a limited prototype for selected retail environments in Malaysia, mainly malls and supermarkets area. The purpose is to test core kiosk functions and assess feasibility, and not a full deployment commercial system.

a. Project

- 1) Kiosk-Based Borrowing and Return Workflow
- 2) The prototype supports a borrow–use–return workflow for customers who need a reusable bag at the point of purchase. The workflow is tested under controlled or simulated mall and supermarket conditions.
- 3) IoT-Enabled Identification and Status Monitoring
- 4) Using RFID identification, the system logs borrowing and return events. The current prototype uses passive RFID cards/tags and an RC522 reader connected to the ESP32. NFC, QR identification, and computer vision remain possible future enhancements.
- 5) Simulated Deposit and Prototype Evaluation
- 6) Deposit and refund are represented only through system records and operating steps. No real money or payment system is used. The prototype evaluation checks basic borrow–return completion, return compliance, and single-location return behaviour.

b. User

- 1) Customers:
- 2) The primary users are customers who borrow reusable bags when they need it and return it following the kiosk workflow.

- 3) Administrators:
- 4) During prototype testing, the system Administrators role are to registers bags, checks bag status logs, and manages kiosk availability.

c. System

- 1) User Interface:
- 2) The kiosk interface are used to display the borrow and return options and the confirmation messages.
- 3) Borrow and Return Recording Process:
- 4) The system logs each borrow and return event, then updates the bag status, keeping the transaction records to used for monitoring.
- 5) System Output:
- 6) The system provides transaction records, that includes borrow confirmations, return confirmations, bag status logs, and the deposit status. No real monetary transactions or payment gateway are implemented.

1.5 Significance of Study

The significant of the project addresses the practical point of purchase barrier. Where consumers may support reusable bag use but used to forgetting to bring bags during shopping. By proposing an IoT-enabled kiosk for borrowing and returning reusable bags in Malaysian malls and supermarkets, the project provides a system-level approach that complements behavioural and policy efforts linked to SDG 12 (Responsible Consumption and Production).

From a sustainability perspective, the project supports reusable bag circulation instead of repeated tote bag purchases. As a proof-of-concept, it does not claim large-scale environmental impact, but it demonstrates a possible way to reduce avoidable bag accumulation and strengthen a structured reuse loop. The simulated deposit-return mechanism also provides an incentive for users to return borrowed bags.

From a retail operation perspective, the project shows how bag availability, basic traceability, and borrow-return records can be supported through a kiosk

workflow. This can reduce dependence on full staff involvement during busy checkout periods while keeping borrowing and returning activities recorded in a structured way.

Academically, the study defines a design and evaluation boundary for an IoT-based, identification-supported reusable bag borrowing system. It also provides a basis for future enhancements, such as real payment integration, multi-location return, and extended evaluation after the initial proof-of-concept feasibility has been established.

1.6 Chapter Summary

This chapter discussed the background, problem statement, objectives, scope, and significance of the SmartBag Kiosk study. Explaining the sustainability issue that are faced in plastic reduction, the challenge of consistent reusable bag use at checkout, and the need for a system that provides a structured borrowing and return system. This chapter also stated that the project is developed as a proof-of-concept IoT-enabled kiosk with RFID-based identification, simulated deposit status, and controlled evaluation in mall and supermarket contexts. The next chapter reviews relevant literature, concepts, and related technologies to support the design of the proposed system.