SMART RECYCLE REWARD BIN – WASTE RECOGNITION AND SORTING FOR REVERSE VENDING MACHINE

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DEDICATION

I would like dedicate this thesis to my parents, who gave the little they had to ensure I would have the opportunity of an education.

ABSTRACT

A Smart Recycle Reward Bin serves as the prototype for a Reverse Vending Machine (RVM) is a cutting-edge idea introduced to western nations to assist in collecting recyclable materials as a result of promoting recycling activities. A reverse vending machine provides an effective, convenient and incentive option to recycle beverage containers. With the help of the RVM prototype, users may earn rewards while recycling aluminium, plastic and paper containers. The container material is identified by the sensor system and it is subsequently deposited into the appropriate bins through the hole. The type of material of the beverage container determines the amount of points awarded for recycling. The total point is added up before being stored in their mobile application. In order to update the latest point, a database will be used. The program includes a user-friendly Graphical User Interface (GUI). Authorized personal and user also will be notified every time the waste reach the maximum level through the mobile apps. The proposed project will provide practical insight into better managing waste disposal to reduce pollution and landfills saturation.

ABSTRAK

Tong Ganjaran Kitar Semula Pintar berfungsi sebagai prototaip untuk Mesin Layan Diri Balikan (RVM). RVM ialah idea termaju yang telah diperkenalkan kepada negara barat untuk membantu dalam pengumpulan bahan kitar semula sebagai hasil untuk menggalakkan aktiviti kitar semula. Mesin layan diri balikan menyediakan pilihan yang berkesan, mudah dan insentif untuk mengitar semula bekas minuman. Dengan bantuan prototaip RVM, pengguna boleh memperoleh ganjaran semasa mengitar semula bekas aluminium dan plastik. Bahan bekas dikenal pasti oleh sistem penderia dan ia kemudiannya didepositkan ke dalam tong yang sesuai melalui lubang. Jumlah mata yang diberikan untuk kitar semula ditentukan oleh jenis bahan bekas minuman. Jumlah mata ditambah sebelum disimpan dalam aplikasi mudah alih mereka. Untuk mengemas kini mata terkini dan menebus mata, pangkalan data akan digunakan. Program ini termasuk Antara Muka Grafik Pengguna (GUI) yang mesra pengguna. Peribadi dan pengguna yang diberi kuasa juga akan dimaklumkan setiap kali sisa mencapai tahap maksimum melalui aplikasi mudah alih. Projek yang dicadangkan akan memberikan gambaran praktikal tentang pengurusan pelupusan sisa yang lebih baik untuk mengurangkan pencemaran dan ketepuan tapak pelupusan sampah.

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LIST OF SYMBOLS AND ABBREVIATIONS

CSS	:	Cascading Style Sheets
HTML	:	Hyper Text Markup Language
IR	:	Infrared
IT	:	Information Technology
LCD	:	Liquid Crystal Display
LDR	:	Light Dependent Resistor
LED	:	Light Emitting Diode
PDA	:	Personal Digital Assistant
RVM	:	Reverse Vending Machine
UI	:	User Interface
UPC	:	Universal Product Code

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Solid waste management is one of the most important services given by municipal governments in the country to maintain cities clean. However, because the mechanisms used are unscientific, antiquated, and inefficient, population coverage is low, and the poor are marginalized, it is one of the worst-performing services in the basket. The situation is worse due to increased urbanization. According to the 2001 Census, the urban population has increased fivefold in the last six decades, with 285.35 million people living in urban areas [1].

The Reverse Vending Machine (RVM) is a novel concept that has been introduced by Western countries to aid in the collection of recyclable materials and, as a result, to increase recycling activity. Wicanders, a Swedish startup, invented this technology in the late 1950s. It was functional, but quite basic and one-dimensional, accepting only one plastic bottle at a time. The machine did not accept other recycled materials, such as aluminum or glass, as well as vast amounts of bottles. An engineer, Aage Tveitan designed and upgraded the reverse vending machine in 1962 to improve this technology. The device could thus accept bottles made of various recyclable materials as well as several bottles at the same time. It is a creative way to collect unwanted beverage containers at the site and use a reward system to boost recycling rates. By dumping recyclable materials such as plastic, glass bottles or aluminum beverage can into the smart machine, user can conserve and collect garbage individually and cleanly at the site where waste happens. Users can choose from a variety of awarding methods to receive the payments. Users are more encouraged to recycle as a result of these incentives since it benefits both the environment and themselves.

The global market for reverse vending machine production is highly concentrated. Tomra Ltd of Norway, Diebold Nixdorf of Germany, and Envipco of the United States compete for the majority of the market. With a market share of 65 percent, Tomra Ltd is the market leader [2]. Table 1.1 shows the analysis of the Reverse Vending Machine for collecting PET bottles.

Table 1.1: RVM and The Characteristic [2]

Company	Producer	Max productivity[a], units/min	Capacity[a]	Price in thou rubles[b]	Rewards
Tomra Ltd	Norway	30/40	200/450 units	no data	no data
Diebold Nixdorf	Germany	40/60	н/д	no data	no data
Envipco Holding N.V.	USA	40/42	300/2333 units	388 – 905	no data
Loetec Elektronische Fertigungssysteme GmbH	Germany	н/д	0,43 m^3	н/д	Cash, coupons, mobile phone account
"RICH", Ltd.	Russia	15	Up to 1 m^3 (20–40 kg of PET bottles)	350	Coupons, utility bills, mobile phone account
PANDA-MAT	Ukraine	12	300 units	125	Cash
Zhengzhou Honest Machinery CO., Ltd	China	30/50	400 units	388 – 646	Coupons, mobile phone account
INCOM TOMRA Recycling Technology (Beijiing) co., Ltd	China	15	335 units	518 – 972	Coupons

1.2 Problem Statement

An automatic self-service machine for recycling is one of the ideas for establishing a smart city. The implementation of the Reverse Vending Machine (RVM) concept as a recycle station can change the city into a better solid management waste. Several problems triggered the idea of developing this project. Users do not receive any returns for the long term every time they recycle their waste is one of the reasons Malaysian people lack a recycling spirit. They prefer to throw away their waste everywhere without considering its effect on nature. On the other hand, there is always dumping of waste at recycle station. Usually, the waste collection will be done once or twice a week according to the schedule. Within that time frame, there is already a lot of waste at recycle station. Customers also need to bring back the recycle waste when the machine is already full of waste and cannot accept even a single waste anymore. Malaysia already has a recycling system with three different coloured containers for different types of waste. Evidently, people must consider and choose which container the rubbish should be placed in. People who do not recycle their waste may dump it in the trash without considering the colour of the bin. This circumstance has a lot to do with how was is sorted. Furthermore, proper waste management plays a main role in a global environment. Therefore, Smart Recycle Reward Bin for Reverse Vending Machine is needed and used in communities, offices and industries as it is part of smart waste management.

1.3 Objectives

This project aims to develop Reverse Vending Machine (Smart Recycle Reward Bin). The objectives of this project are:

1. To develop a mobile app to offer personal rewards for the end-user.
2. To track the waste level inside the beverage container.
3. To analyze the effectiveness of sensors to differentiate the different types of material.

1.4 Scope of Work

The scope of this project is divided into two parts; hardware and software. Several sensors will be used in Smart Recycle Reward Bin for the hardware part. A sensor circuit will be developed to recognize the type of waste material, identify the container waste and detect the maximum level of the container. The mechanism design on the prototype will also be designed to accommodate the sensors placement. For the software part, a mobile app will be developed and placed on the prototype of the Reverse Vending Machine. A mobile app sends a notification to the user and be authorized every time the container reaches the maximum level and update the user's recent reward point.

1.5 Importance/ Significant

It is the responsibility of all citizens to recycle their waste. This act is considered as responsible 'green' citizenship. The majority of European consumers have made recycling part of their everyday routine. Today, most people associate contemporary recycling with the 1970s, when grass-roots campaigns and environmental policies resulted in new consumer practices [3]. For several years, the recycling of solid wastes such as plastic bottles, glass bottles and aluminum can have been concern. State and local governments have gotten more interested in recycling as environmental concerns have become more significant to individuals. Many cities now provide convenient recycling options for residents, such as drop-off locations or curbside pickup. Unfortunately, despite the fact that many communities have made recycling process easier, compliance still remains low. Given the high reliance on individual cooperation for successful recycling, it is clear that a better knowledge of the antecedents of recycling behaviors would be tremendously beneficial [4].

Hence, Reverse Vending Machine (RVM) is designed to encourage recycling by rewarding recyclers with reward point for each item recycled. Many big countries have already implemented RVM machines after realizing the benefits. Despite Malaysia's efforts to reduce waste, RVM machine is not widely employed yet due to its expensive installation and high maintenance costs. The main goal of this project is to help Malaysia implement the RVM machine by creating a prototype of the machine that focuses on reducing installation and maintenance cost simultaneously.

CHAPTER 2

LITERATURE REVIEW

This chapter presents the finding of the previous study that are relevant to this project. These studies also serve as the key source of information for the project with the theoretical, methodological and interpretation of the studies assisting in the material support.

2.1 Reverse Vending Machine

The first RVM, dubbed the 'Bottle Return and Handling Machine' was invented in the United States in 1920. There are currently over 100,000 RVMs deployed all over the world. An example of a Reverse Vending Machine is shown in Figure 2.1. [5]

Figure 2-1: A simple Reverse Vending Machine [5]

The RVM is the type that accepts empty recycle waste and rewards the user in cash or a deposit receipt and is seen at supermarkets and other locations. The principle work of the reverse vending machine is a quick simple idea. The user will place the waste in the machine and automatically rotate it for bar-code scanning. Next, the waste will have transported to a container when the bar-code is identified and matched with a universal product code (UPC) in a database. Instead of scanning, some RVM uses a material identification system that weighs the item [5]. The end user is usually given a deposit or return amount by machine. This distinguishes it as a 'reverse' vending machine instead of inserting money and receiving a commodity like a candy vending machine. The concept is that users insert a product and will receive a monetary value as a return.

There are two key reasons deposit return schemes succeed in raising recycling rates and, at the same time can reduce pollution. First, the public has a financial incentive to recycle. Users are rewarded financially for returning beverage containers under deposit return systems. Instead of being perceived as trash, this shows that containers