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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

FINAL YEAR PROJECT REPORT

DESIGN AND DEVELOPMENT OF AN INFORMATION MANAGEMENT SYSTEM FOR ELECTRICITY PAYMENT IN UMEME YAKA METERS

BY

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A final year Project report submitted to the Department of Electrical Engineering in Partial fulfillment of the Requirement for the award of a Bachelor of Science degree in Electrical Engineering of Busitema University.

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DECLARATION

I the undersigned, declare that this report is my original work except where due acknowledgement has been made. I declare that this work has never been submitted to this university or any other institute of learning for partial fulfillment for any award.

Name: AGUTI AGNES STELLA

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Date ……/……/…….

APPROVAL

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ACKNOWLEDGEMENT

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DEDICATION

I dedicate this report to my beloved parents, siblings, and friends.

ABSTRACT

This project report seeks to address the challenges associated with manual electricity unit loading in UMEME Yaka meters by designing and developing an innovative information management system aligned with Uganda's development goals. The current system requires users to input a lengthy 20-digit token physically, leading to errors and inconvenience, especially during unit shortages. To mitigate these challenges, the proposed solution involves implementing GSM-based technology for automatic and remote activation, eliminating the need for physical interaction with the customer interface unit (CIU). Research methods like observation, interviews, and literature review were utilized to gather insights and identify technological solutions. A prototype was developed using Atmel ATMEGA328P-PU microcontroller advanced technology, interfaced with a SIM800L quad-band GSM modem. This prototype was able to automatically load the tokens when payment was made and the project objectives were met as indicated by the outcomes as demonstrated in the report. This project aligns with Uganda's objectives of promoting technological innovation, economic growth, and sustainable development, representing a significant step towards modernizing the country's electricity infrastructure and facilitating socio-economic progress.

LIST OF ACRONYMS

ASK: Amplitude Shift Keying

BER: Bit Error Rate

CPCA: Carrier Present, Carrier Absent

CPU: Central Processing Unit

DFD: Data flow diagrams

DRAM: Dynamic Random Access Memory

EEPROM: Electrically-erasable programmable Read Only Memory

FCC: Federal Communications Commission

GPS: Global Positioning System

GSM: Global System for Mobile communication.

I2C: Inter Integrated Communication

LNA: Low Noise Amplifier

OOK: On Off Keying

PCB: Printed Circuit Board

RAM: Random Access Memory

RISC: Reduced instruction Set Computer

RF: Radio Frequency

ROM: Read Only Memory

SPI: Serial Peripheral Interface

SRAM: Static Random Access Memory

TWI: Two Wire Interface

UART: Universal Asynchronous Receiver Transmitter

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1 CHAPTER ONE

1.1 Introduction

This chapter covers the project's background, problem statement, general objectives, research questions, scope, significance, and conceptual framework. This report examines the design and physical modeling of a GSM-based Electricity Recharge System for prepaid metering in Uganda, commonly referred to as YAKA. Currently, users must enter a 20-digit token number provided after any payment, with a maximum of three attempts before the meter locks. If locked, customers must repeat the entire process they followed to obtain their electricity account. Given the length of the token, there is a high likelihood of incorrect input, making it challenging to get the sequence right. Additionally, entering the 20-digit token number is cumbersome, as it necessitates the user's physical presence at the customer interface unit. At present, there is no way to remotely input the token to activate purchased units.

The project's goal is to reduce errors by introducing a new method of loading the 20-digit token number without the need for physical interaction with the customer interface unit. This will allow users to recharge their electricity accounts remotely, without needing to be physically present at the customer interface unit.

1.2 Background

Smart meters have become essential components of modern utility systems worldwide, transforming how energy consumption is monitored, managed, and billed. Initially introduced in regions such as the United States, United Kingdom, Canada, and Europe, these devices replace traditional analog meters with advanced features, including digital displays and bi-directional communication capabilities. Analog meters presented challenges such as limited accuracy, manual reading requirements, and inability to detect energy theft or tampering. In contrast, smart meters offer numerous advantages, including remote monitoring, outage detection, and enhanced energy efficiency, empowering consumers to make informed decisions about their energy usage. As global adoption continues to grow, smart meters play a crucial role in advancing sustainability and efficiency in the energy sector through ongoing technological advancements and integration with renewable energy sources.

Recent advancements in smart meter technology, including the implementation of Secure Token Systems (STS) and Standard Transfer Specification (Smith, 2022) have played a pivotal role in the upgrading of meters. The globally adopted STS for prepayment metering protects

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