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**A LOCATION-BASED COMMODITY ORDERING AND DELIVERY SYSTEM: CASE  
OF BOARDING SCHOOLS IN NAIROBI**

By

ISAIAH OUMA OTIENO

REGISTRATION NUMBER: 083751

A Thesis Submitted to the Faculty of Information and Technology in partial fulfillment of the requirements for the award of Master of Science in Information Technology of Strathmore University

**STRATHMORE UNIVERSITY**

June 2019

## Declaration and Approval

I ISAIHAH OUMA OTIENO declare that this research has not been submitted to any other University for the award of a Master's Degree in Information Technology of Strathmore University



Student Name: ISAIHAH OUMA OTIENO

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Date: \_\_\_\_\_

Supervisor's Name: DR. BERNARD SHIBWABO

Sign: \_\_\_\_\_

Date: \_\_\_\_\_

## Dedication

I dedicate this project with much love and appreciation to my family; my beloved wife Grace Seli, my beloved daughter Venessa Andrews and to my beloved sons Albert Mjomba and Okoth Ombewa, whom without their support, I would not have made it. They give me the push I need to take that extra stride no matter how tough things are!!!



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I offer my deepest appreciation to Joshua Ogola who has been a father figure in my life, also pushing me to be better in whatever I do. I celebrate Joshua for always showing me the path when the bush seems too thick, always pointing out another hill that I can scale and stressing the importance of self-improvement. I would also like to take this opportunity to thank Rev. Ismael Owiti Oloo of ACK Mudhiero Parish. I would not be the person I am without the foundation accorded to me by Rev. Ismael. It is with much gratitude that offer my never-ending appreciation to Stephen Odhiambo Mumbo and George Phillip Oloo Pedo both of whom were my Primary School teachers at Pap-Nyadiel Primary school. I would not have even dreamed of what I am today if it was not the guidance and support of these two teachers who dedicated their work to ensuring a better future for the pupils that passed through their hands.

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## Abstract

There is general preference of boarding schools by parents in the bracket of middle and upper class to ease pressure of caring for the children vis a vis work pressure. The matter is compounded by new Kenyan government policies on employment of *house helps* and the distance of the schools from the location where the parents stay.

From time to time, students in boarding schools require replenishing of simple supplies and consumable subject to school regulations. This scenario presents a new challenge in that families are unable to tend effectively to the needs of the students in boarding schools due to distance and time limitations.

This research sought to explore the development of a system that allows online purchases and delivery of supplies to students in boarding schools by a touch of a button irrespective of the location of the school. The proposed solution consists of a Web-based and mobile application that allows a student to make a request that a parent approves before the delivery is made to the student.

The system works by locating the supplier nearest to the school to reduce on the time taken to deliver the commodity as much as possible. The system utilizes a matrix that works by getting the nearest delivery person (Motorbike delivery person) that is closest to the supplier to save on time and cost. The supplier and the delivery person both get paid after successful delivery of the commodity

Agile development methodology and object-oriented analysis and design were used in this. The final prototype of the location-based commodity ordering and delivery system was tested to ensure the functional and non –functional requirements were met by the system and the system was tested in fourteen schools in Nairobi County with eighty percent satisfaction rate from parents and students who used the system.

**Keywords:** Location Based Services, Web Application, Mobile Application, Commodity Ordering, Boarding Schools

## Table of Contents

Declaration and Approval .....	ii
Dedication .....	iii
Acknowledgement .....	iv
Abstract .....	v
Table of Contents .....	vi
List of Tables .....	xiii
List of Figures .....	xiv
Definition of Terms .....	xvii
Abbreviations and Acronyms .....	xviii
Chapter 1 : Introduction .....	19
1.1. Background .....	19
1.2. Problem Statement .....	20
1.3. Aim .....	21
1.4. Specific Objectives .....	21
1.5. Research Questions .....	22
1.6. Justification .....	22
1.7. Scope and Limitation .....	23
Chapter 2 : Literature Review .....	24
2.1. Introduction .....	24
2.2. Theoretical Framework .....	24
2.2.1. Challenges that Face Commodity Ordering and Delivery in Boarding Schools.....	24
2.2.2. The Current Techniques, Models and Technologies Used in Building Location Based Systems.....	25
2.2.2.1 Location Identification Technologies.....	28
2.3. Review of Similar Projects to Location based Commodity Ordering and Delivery System .....	30
2.4 Location and Context based Platforms .....	32

2.4.1	Sendy .....	32
2.4.2	Uber .....	33
2.4.3	CarreFour .....	34
2.4.4	High schools Embracing Technology .....	34
2.4.4.1	Biometric Sign-in in Schools .....	35
2.5	How the Location-based Commodity Ordering and Delivery System Different from the Platforms Currently in the Market .....	<b>Error! Bookmark not defined.</b>
2.5.1	Parent in Control of the Purchase .....	<b>Error! Bookmark not defined.</b>
2.5.2	School Administrator Keeps an Overview and Control....	<b>Error! Bookmark not defined.</b>
2.5.3	The Parent is Not Liable until the Oder is Delivered .....	<b>Error! Bookmark not defined.</b>
2.5.4	Partnership with Boarding Schools .....	<b>Error! Bookmark not defined.</b>
2.5.5	Coverage of Service .....	<b>Error! Bookmark not defined.</b>
2.6	Value Preposition .....	35
2.7	Conceptual Framework/Proposed Architecture .....	36
Chapter 3 : Research Methodology.....		37
3.1.	Introduction .....	37
3.2	Research Design.....	37
3.3	Agile Software Development Methodology .....	38
3.3.1.	Planning Phase .....	39
3.3.2	Requirements Analysis Phase .....	40
3.3.2.1.	Location of the Study.....	41
3.3.2.2.	Target Population .....	42
3.3.2.3.	Sample Size .....	44
3.3.2.4.	Data Collection.....	45
3.3.2.5.	Data Analysis .....	46
3.3.3	Design Phase .....	47
3.3.4	Development Phase .....	49
3.3.5	Prototype Evaluation and Testing .....	50
3.3.5.1	System Testing .....	51
3.3.5.2	Testing of the Prototype .....	45
3.3.6	Ethical Issues.....	52

Chapter 4 : System Design and Architecture .....	53
4.1. Introduction .....	53
4.2. Data Analysis .....	53
4.2.1 Degree of Response.....	54
4.2.2 Parents of Boarding School Students .....	54
4.2.2.1 Number of Children in Boarding Schools .....	54
4.2.2.2 Number of Children in Boarding School - Secondary Level .....	55
4.2.2.3 Whether School is Public or Private.....	55
4.2.2.4 Whether the School have Midterm Break .....	56
4.2.2.5 Number of Times the Parent See the Student.....	56
4.2.2.6 Whether the Student is Allergic to Any Food Items .....	57
4.2.2.7 Whether Home Leave is Allowed in School .....	58
4.2.2.8 Whether the Parent has Ever Been Stuck in Delivering Commodity to Student in School Due to Time or Distance to School Constraint.....	58
4.2.2.9 Whether the Parent thinks they Need Commodity Delivery System to help them Deliver Commodity to the Student.....	59
4.2.2.10 The point at which Parents would make Payment, if they were to have such a System .....	60
4.2.2.11 On Whom Parents Would Like to Make Confirmation of Delivery of the Commodity .....	60
4.2.3 Students of Boarding Schools .....	61
4.2.3.1 The Gender of the Student.....	61
4.2.3.2 Form/Class of the Student .....	62
4.2.3.3 Whether School is Public or Private.....	62
4.2.3.4 Whether the School have Midterm Break .....	63
4.2.3.5 The Times a Student Gets to see the Parent in a Term.....	63
4.2.3.6 On What Mechanism the Student Prefers to Use in Logging in to the System.....	64
4.2.3.7 Whether there are Rules on Edible Products that are Allowed in School .....	65
4.2.3.8 Whether Home Leave is Allowed in School .....	65
4.2.3.9 Whether a Student has ever been “Stuck” because a Parent could not get them a Personal Effect of Commodity in Time.....	66

4.2.3.10 Whether the Students thinks they Need Commodity Delivery System to Help their Parents deliver Commodity to them. ....	67
4.2.3.11 The Number of Times a Week the Students Would Need to Access Such a System if it were to be Implemented.....	67
4.2.3.12 On which Day the student would Prefer to Access the System; for the Majority of Students who wants to Access the System once a Week .....	67
4.2.3.13 On whom the students would recommend to collect the delivered commodity.....	68
4.2.3.14 The Point that the Students want to make Confirmation to their Parents on the Safe Delivery of the Products .....	69
4.2.4 Boarding Schools Administrators .....	69
4.2.4.1 Whether School is Public or Private.....	69
4.2.4.2 Whether the School have Midterm Break .....	69
4.2.4.3 The Number of School Events that Involve Parents Coming to School .....	69
4.2.4.4 Whether there are Rules on Edible Products that are Allowed in School .....	70
4.2.4.5 Whether Home Leave is Allowed in School .....	71
4.2.4.6 Whether the Schools Allows Interaction with the Outside World .....	71
4.2.4.7 Whether the Schools would Allow Vetted Individuals from Supermarket Chains to Deliver Commodity to Students. ....	72
4.2.4.8 Thoughts of the School Administrator on Implementing Commodity Delivery System for Students in School.....	72
4.2.4.9 Thoughts of the School Administrator on who the School would Allow to Access such a System if it were to be Implemented.....	73
4.2.4.10 Thoughts of the School Administrators on how many times they Would Allow Students to Access such a System and on what Days, if it were to be Implemented.....	73
4.2.4.11 Thoughts of the School Administrator on how the School would like to Interact with School Phase of the System.....	73
4.2.4.12 Thoughts of the School Administrator on who the School would Prefer to Collect the Delivered Commodity and whether they would like to Vet the Commodity before Handing Over to the Student .....	73
4.2.5 Summary of Data Analysis .....	73
4.2.6 Data Analysis Discussions .....	74
4.3. Requirements Analysis.....	75
4.3.1. Functional Requirements.....	76
4.3.2. Non-functional Requirements .....	77

4.4. System Design.....	78
4.4.1 System Architecture .....	80
4.4.2 Context Diagram .....	80
4.4.3 Use Case Diagram.....	81
4.4.4 Sequence Diagram.....	85
4.4.5 Data Flow Diagram .....	86
4.4.6 Entity Relationship Diagram.....	88
4.4.7 Database .....	89
4.4.8 Web .....	90
4.4.9 API .....	91
4.4.10 Mobile Application .....	91
4.4.11 Google Map and GPS.....	92
Chapter 5 : System Implementation and Testing.....	94
5.1 Introduction .....	94
5.2 System Implementation.....	94
5.2.1 Work Flow.....	94
5.2.1.1 Normal Request .....	94
5.2.1.2 Request Initiated by the Parent.....	95
5.2.2 Application Hardware Requirements.....	95
5.2.2.1 Server Specifications .....	95
5.2.2.2 Mobile Application.....	96
5.2.3 Application Software Requirements .....	96
5.2.3.1 Framework.....	96
5.2.3.2 Language .....	96
5.2.3.3 JavaScript.....	97
5.2.3.4 Webpack (asset building) .....	97
5.2.3.5 Ionic .....	97
5.2.3.6 MariaDB (10.2) .....	97
5.2.4 System Users and Graphical User Interface.....	98
5.2.4.1 Landing/Home Page .....	98
5.2.4.2 Sign-In Page .....	99

5.2.4.3 Sign-Up page .....	101
5.2.4.4 User Roles.....	103
5.2.5 Main Modules and Graphical User Interface .....	104
5.2.5.1 Parents Dashboards.....	104
5.2.5.2 School Administrator’s Dashboards .....	106
5.2.5.3 Commodity Supplier Dashboards.....	107
5.2.5.4 Student Dashboards .....	109
5.2.5.5 Delivery Person Dashboard .....	110
5.3 System Testing .....	113
5.3.1 Functional Testing.....	113
5.3.2 Prototype Validation Results.....	116
5.3.3 Usability Testing .....	124
5.3.4 Regression Testing .....	125
5.3.4.1 Creation of Account.....	125
5.3.4.2 Signing in to the System .....	127
5.3.4.3 Parent Adding a Child .....	127
5.3.4.4 Initiating an Order .....	128
5.3.4.5 Parent Approving an Order.....	129
5.3.5 Compatibility Testing.....	130
Chapter 6 : Discussion .....	131
6.1 Introduction .....	131
6.2 Findings and Achievements .....	131
6.3 Review of Research Objectives in Relation to the Mobile Application .....	132
6.4 Advantages of the Application in Contrast with the Current System .....	133
6.5 Limitations of the Application .....	133
Chapter 7 : Conclusions, Recommendations and Future Work .....	134
7.1 Introduction .....	134
7.2 Conclusions .....	134
7.3 Recommendations .....	135
7.4 Future Work .....	136
REFERENCES .....	137

APPENDICES ..... 151

Appendix A: Time Schedule ..... 151

Appendix B: NACOSTI Research Permit..... 152

Appendix C: Turn It In Match Overview ..... 153

Appendix D: Turn It In Report..... 154

Appendix E: Student Questionnaire ..... 155

Appendix F: School Administrators Questionnaire ..... 159

Appendix G: Parents Questionnaire ..... 163

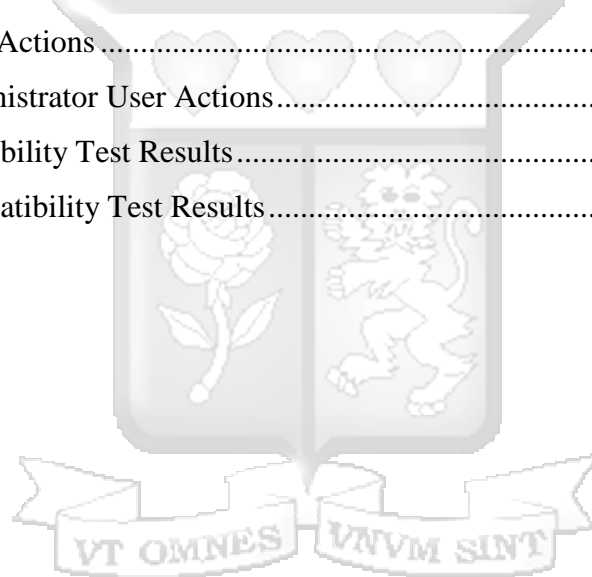
Appendix H: Data Collection Reference Letter from Supervisor ..... 167

Appendix I: NACOSTI Research Authorization Letter ..... 168



## List of Tables

Table 2.1 : Location identification technologies.....	28
Table 3.1: Number of Schools in Nairobi County by Accommodation Status.....	42
Table 3.2: Secondary Schools Enrollment by School Status in Nairobi County.....	45
Table 4.1 : Worldwide Smartphone OS Market Share (Share in Unit Shipments) .....	79
Table 4.2: Use Case Main Success Story.....	81
Table 5.1 : Functional Testing Variables and Results .....	113
Table 5.2 : General User Actions.....	116
Table 5.3 : Parent User Actions .....	117
Table 5.4 : Supplier User Actions.....	119
Table 5.5 : Student User Actions .....	121
Table 5.6 : School Administrator User Actions.....	123
Table 5.7 : Web Compatibility Test Results.....	130
Table 5.8 : Mobile Compatibility Test Results.....	130



## List of Figures

Figure 2.1 : Convergence of Technologies to Create Location Based Services .....	26
Figure 2.2: Layered Conceptual Framework for Context-aware Systems.....	27
Figure 2.3 : Context Feature Space, Detailing Location as One Feature in the Conditions of the Physical Environment .....	28
Figure 2.4 : Location Based Services Architecture .....	30
Figure 2.5: Conceptual Framework of the Service Delivery Platform .....	36
Figure 3.1: Agile Methodology.....	39
Figure 3.2: Agile Development Value Proposition.....	<b>Error! Bookmark not defined.</b>
Figure 3.3 : Stakeholder Identification .....	<b>Error! Bookmark not defined.</b>
Figure 3.4 : Stakeholders for the Proposed Platform.....	43
Figure 3.5: Mobile Devices Main Screen Resolutions .....	48
Figure 3.6: Mobile Devices Navigational Schemes.....	49
Figure 4.1 : Number of Children a Parent has in Boarding Schools.....	55
Figure 4.2 : Number of Children a Parent has in Boarding Schools at Secondary Level.....	55
Figure 4.3 : Whether School which a Student is Enrolled in is Public or Private .....	56
Figure 4.4 : Number of Times a Parent Gets to See the Child in a Term .....	57
Figure 4.5 : Whether the Student is Allergic to Some Food Items or Not.....	57
Figure 4.6 : Whether Home Leave is Allowed in School .....	58
Figure 4.7 : Whether a Parent has Ever Registered Frustration in Getting a Personal Item or Commodity to Student in School.....	59
Figure 4.8 : Need of Commodity Delivery System by the Parents.....	59
Figure 4.9 : Parents Preference on When to Make the Payment .....	60
Figure 4.10 : Parents Preference on Whom They Would Like to Make Delivery Confirmation .	61
Figure 4.11 : Gender of the Students Taking Part in the Study .....	61
Figure 4.12 : Classes/Forms of Students Interviewed .....	62
Figure 4.13 : Type of School the Student is Enrolled in.....	63
Figure 4.14 : Number of Times the Parent Gets to See the Child in a Term.....	64
Figure 4.15 : Mechanism for Student Login to the System .....	64
Figure 4.16 : Rules on Edible Products that are Allowed in School.....	65
Figure 4.17 : Whether Home Leave is Allowed in School .....	66

Figure 4.18 : If a Student has Ever Been Frustrated in Commodity/Personal Item Getting Delivered to them in School. ....	66
Figure 4.19 : Number Time(s) the Student would Like to Access the Commodity Delivery System.....	67
Figure 4.20 : Day Preferred by the Students to Access the System.....	68
Figure 4.21 : Students’ Preference on Collection of Commodity.....	68
Figure 4.22 : Type of School Taking Part in Survey .....	69
Figure 4.23 : Events Per Term that Parents can Attend.....	70
Figure 4.24 : Rules on Edible Products .....	70
Figure 4.25 : Option of Home Leave .....	71
Figure 4.26 : Schools Allowance of Interaction with Outside World.....	71
Figure 4.27 : Openness of Schools to Allow Vetted Individual to do Delivery .....	72
Figure 4.28 : School Administrators’ Comments about the System.....	73
Figure 4.29 : Worldwide Smartphone OS Market Share (Share in Unit Shipments).....	79
Figure 4.30 : System Architecture .....	80
Figure 4.31 : Context Diagram of the System .....	81
Figure 4.32 : Use Case Diagram.....	84
Figure 4.33: Sequence Diagram of the System.....	85
Figure 4.34 : Data Flow Diagram of the System .....	87
Figure 4.35 : Entity Relationship Diagram of the System .....	89
Figure 4.36 : Block Diagram of GPS Component of the System .....	93
Figure 5.1 : Web Interface of the Landing Page for Commodity Ordering and Delivery Service	98
Figure 5.2 : Mobile Interface of the Landing Page for Commodity Ordering and Delivery Service .....	99
Figure 5.3 : Web Interface Sign-in Page.....	100
Figure 5.4 : Mobile Interface Sign-in Page.....	101
Figure 5.5 : Web Sign-up page .....	102
Figure 5.6 : Mobile Sign-up page .....	103
Figure 5.7 : Parent Profile Dashboard - Web Impression.....	105
Figure 5.8 : School Administrator Profile Dashboard - Web Impression.....	106
Figure 5.9 : Commodity Supplier Profile Dashboard - Web Impression .....	108

Figure 5.10 : Student Profile Dashboard - Web Impression ..... 110

Figure 5.11 : Delivery Person’s Dashboard - Mobile Impression ..... 111

Figure 5.12 : Delivery Person’s Direction Map - Mobile Impression ..... 112

Figure 5.13 : Parents’ Usability Feedback ..... 125

Figure 5.14 : User Sign-Up Page ..... 126

Figure 5.15 : Automatic Registration Email ..... 126

Figure 5.16 : User Sign-in ..... 127

Figure 5.17 : Adding a Child User Interface ..... 128

Figure 5.18 : The Interface for Initiating a Request ..... 128

Figure 5.19 : Parents’ Screen Before Confirming an Order ..... 129

Figure 5.20 : Confirmed Order ..... 129



## Definition of Terms

**Algorithm:** A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer (Dictionary.com, n.d).

**Arrays:** An array is a data structure that contains a group of elements. (Christensson, 2007).

**JavaScript:** JavaScript is the only scripting language able to run on nearly all browsers (Gamage & Dong, 2006).

**JSON:** JavaScript Object Notation (Goyal, Singh, & Ramkumar, 2017; Guo, Xia, & Xiang, 2017).



## Acronyms

**API:** Application Programming Interface (Nawaz, Juve, Da Silva, & Deelman, 2016).

**CRB:** Credit Reference Bureau (Magut, 2018).

**CSS:** Cascading Style Sheet (W3schools.com, 2018).

**ERD:** Entity Relationship Diagram (Technopedia, 2016).

**FPE:** Free Primary Education (Odunga, 2014).

**GPS:** Global Positioning System (Lin, Yang, Do, & Chen, 2013; Sunehra, Priya, & Bano, 2016).

**GSM:** Global System for Mobile Communication (Sunehra et al., 2016).

**IDE:** An integrated development environment (IDE) (Fuad, Deb, & Etim, 2014).

**KCSE:** Kenya Certificate of Secondary Education (Wanzala, 2016).

**NACOSTI:** National Commission for Science, Technology and Innovation (User, 2019)

**SDK:** A software development kit (Fuad et al., 2014).

**USSD:** Unstructured Supplementary Services Data (Lakshmi & Gupta, 2017).

**VPS:** Virtual Private Servers (UpGuard, 2017).

**SASS:** Syntactically Awesome Style Sheets (Wheeler, 2014)

**LBS:** Location-based Services (Manifest, 2018)

## Chapter 1 : Introduction

### 1.1. Background

Kenya is ranked as the ninth largest economy in Africa, with gross national income (GNI) per capita, \$1,160 (Gundan, 2014; United Nations Economic Commission for Africa, 2015). This makes Kenya to be ranked as a middle income country.

One of the clear symptoms of the high GDP is the constantly growing middle class in the country. With a growing middle class (Blerk, 2018; Kapchanga, 2015) and a demanding economy - convenience is a critical offering in any product or service. Kenya's economic gains over the last few years have been dubbed as nothing short of remarkable (Lagarde, 2014). And few are benefiting more from this progress than the country's burgeoning middle class. The middle-class population in Kenya now stands at 44.9% of the total population, translating to 21.2 million people who form a powerful purchasing block (Kapchanga, 2015; Mungai, 2011).

Pew research uses a much narrower albeit internationally recognised, definition of middle-class income of \$10 a day or more (Blerk, 2018). The onset of Free Primary Education (FPE) in January 2003 resulted in increase in enrolments from 5.8 million children in December 2002 to 7.2 million in May 2003, a GER of 104%. This was the best thing that had happened to Kenyan children (United Nations, 2017).

With the growing middle class, lifestyle changes are unavoidable with most families seeking active employment for both partners to make ends meet. Demographics in Kenya as discussed in the preceding paragraphs, indicate that a majority of the middle and upper class families are based in urban areas/centers. On the flip side, a number of boarding schools particularly high schools are based outside the urban areas. Parents prefer boarding schools to ease social pressures and also ensure professional care for their children. With the Kenyan government setting the minimum wage of domestic workers to approximately KES 11,000 in 2015; the dynamics of family arrangement especially in the urban areas changed as most of the families could not afford this amount. Such changes in policies have added more pressure to the urban families hence pushing them to embrace boarding schools as a solution.

From time to time, students in boarding schools will require replenishing of simple supplies and consumable subject to school regulations. This scenario presents a new challenge in that families are unable to tend effectively to the needs of the students in boarding schools. In many cases, parents are juggling time and resources to address delivery needs of students in boarding schools.

This research which sees deployment of online based platform; MobiDel which is looking to offer ordering and delivery solutions case of boarding school students. The system is set to be launched in the Nairobi area of the country where statistics show that there are 143 boarding schools (Education, 2014). The successful deployment of the system and rollout of the services will see engagement and deployment of suppliers and delivery persons to create an elaborate upstream supply network; something that is out of scope of this study.

This is achieved by deploying a system to provide the linkage between the student and the parent or guardian. The cloud-based platform is a location based system that provides the students with choices of products based on the school rules and regulations on the supplies allowed by the school in question. Boarding schools in Kenya have different rules and regulations in regard to supplies allowed and contact with the outsiders such as the delivery persons; the system takes this into context while servicing the users and provide users with the correct interface and hence service.

The system is predominantly a mix of web based and mobile based system, taking advantage of the high mobile penetration in the country. It is estimated that 73% of Kenya's inhabitants use mobile-cellular technology (CommunicationLifeline, 2017) and approximately 43.4% of the population have access to the internet (Wainaina, 2017). Payments is made online using a mobile money payment platform that will be interfaced to the application back end.

## **1.2. Problem Statement**

In recent years, primary boarding schools have become popular; this has been attributed to the fact that in most families, both parents are engaged in active employment. This coupled with government policies such as *low cost boarding primary schools programme* aiming to increase enrolment and retention of pupils in schools in Arid and Semi-Arid Lands (Odunga, 2014; Oduor, 2017) has seen the number of boarding schools go up. Parents prefer boarding schools to ease social pressures and also ensure sound care for their children. This scenario is even more enhanced

with the fact that students do not necessarily study in the same town as the one the parents work. This is because most upper class families are based in urban areas while a number of the boarding schools particularly high schools are based outside the urban areas – a research by African Population and Health Research Centre found that 8.5% of the 12.4% of respondents who study in boarding schools had their school in the rural areas of Kenya while only 2.1% had their schools in the urban areas (APHRC, 2016).

Every boarding school with a website has school supplies section where parents can download a list of supplies they need to buy as they take their children back to school (Jono, 2017). This and other challenges discussed in the above paragraphs points to a strong need for a commodity ordering and delivery system, case of boarding schools to help parents order commodities for their children away in boarding schools. From a computing perspective, the solution is expected to address the need for commodity ordering by students in boarding schools supported by their parents who are often in a separate location while at the same time giving parents and school administrators control to approve the orders. The system works by locating the closest supplier to school and the closest delivery person to the supplier to deliver the order hence cutting down on time wastage and saving on costs.

This platform accessible via mobile application developed for Android and iOS phones users and a web-based version is also developed for school administrators who preferred web-based application and users who prefer using their computer.

### **1.3. Aim**

The aim of this study is to develop a platform that conveniently, efficiently and effectively facilitate the requesting supplies and delivery of the same: in this case requesting of school supplies by the boarding students, the ordering of commodity by parents and the successful delivery of the orders to the student that initiated the order.

### **1.4. Specific Objectives**

- I. To investigate the challenges that face commodity ordering and delivery
- II. To analyse current techniques, models and technologies used in location based services.

- III. To develop a system that supports ordering and delivering of supplies to students through the power of location based services.
- IV. To validate that the developed location based supplies ordering and delivery system so as to confirm that it provides a proper location based service to student, parents, guardian and school needs

### **1.5. Research Questions**

- I. What challenges face commodity ordering and delivery in boarding schools?
- II. What are the current techniques, models and technologies used in building location based platforms?
- III. How can a system that supports ordering and delivering of supplies to students through the power of location based services be developed?
- IV. How can the developed location based supplies ordering, and delivery system be tested?

### **1.6. Justification**

The platform has a number of benefits to the various stakeholders of the platform. The greatest beneficiary and the main reason why the system was conceived is the convenience and efficiency the system provides to the parent of students in boarding schools. The parents can rest easy knowing that at a press of a button, they are able to deliver commodity to their children away in school in any corner of this country, Kenya. The students on the other had can now focus more on their studies, knowing that their needs can be well taken care of albeit remotely by the parent. This will have direct impact on the school's performance regionally and nationally not to mention reduced amount of unrest by students in terms of strikes due to frustrations.

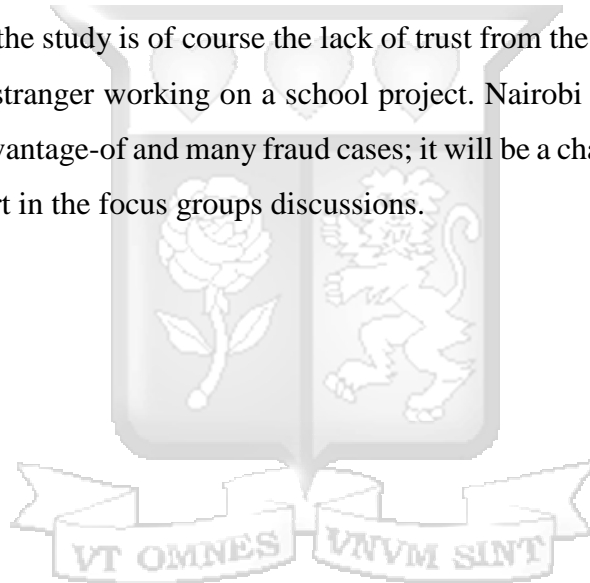
The platform serves as a one stop communication tool for the school as well as the government with the parents. This comes in handy in communicating with the key stakeholder in education in case of change in policy that directly affects the students and the parents, for instance the scrapping of the visiting day. The platform fosters new supply chain to emerge, resulting to supermarket outlets not only depending on walk in clients but also orders from the school via the platforms. The direct result of this is employment creation where the suppliers have to enrol delivery

person(s) and good example for the ministry concerned to use the platform as an example of solving society problems by adoption of technology.

## **1.7. Scope and Limitation**

The focus of this study is on secondary boarding schools in Nairobi County. The aim is to get the response of parents and students in regard to having a service that conveniently helps in delivering commodities to students in boarding schools at a touch of a button. Of interest to the study also for the parents residing in Nairobi, will be how far they are from their children schools and how often they make time to visits their children in schools.

The biggest limitation to the study is of course the lack of trust from the administration on sharing information with a total stranger working on a school project. Nairobi having incidence of good intentions being taken advantage-of and many fraud cases; it will be a challenge to convince school administration to take part in the focus groups discussions.



## Chapter 2 : Literature Review

### 2.1 Introduction

Any parent wants the best for their children whether children are at home or at school. This is the main reason why parents spend their fortune to take their children to boarding schools in the fast place. A parent would strive to provide the best possible life to their children. One way of doing this is ensuring that their children needs are well taken care off while away in school. Otherwise we would not be having hypothesis that belief in myths idealizing parenthood helps parents cope with the dissonance aroused by the high financial cost of raising children (Eibach & Mock, 2011). However, paradox of life is that, parents must work hard to provide the needs of their children and might not always have time to visit and/or replenish their children supplies while their children are away in school.

This matter gets compounded by the fact that students in boarding schools do not have a clear avenue of communication with their parents when needs arises. This forces the students to be at the mercy of teachers by borrowing teacher's phones to make calls to their parents or caregivers. With some schools having quotas on how often a student can be visited or get a student home slip, this problem becomes an area that needs attention. The matter was engraved with the recent policy that banned all social activities including visiting of form four students before Kenya Certificate of Secondary Education (KCSE) (Wanzala, 2016; Oduor, 2016).

### 2.2 Challenges Facing Commodity Ordering and Delivery

The platform structure is in a form of a workflow: The student makes a request; the request is passed over to the parent; the parent confirms the order by authorizing and committing payment for the delivery; the supplier delivers the requested commodity to the school. For this platform to solve the problem successfully, all the stakeholders must be on board. Last but not least, the government in form of the ministry must be on board as well. Most of the policies that determine the running of the schools come from the ministry of Education. Policies such as the banning of all social activities including visiting of form four students before Kenya Certificate of Secondary Education (KCSE) (Wanzala, 2016; Oduor, 2016) and that of no head-teacher or principal that will

serve in the same school for a period that exceeds nine years (Oduor, 2017) have direct impact on the platform. Such a policy may seem neutral from a far but if you look closer it may have impact on the platform. A case in point would be having a head teacher that is supportive of the platform be transferred to a different school giving way to a head teacher that likes running the school in a more traditional and rigid manner.

Generally, every school has a set of regulation and rules that guides the school on how the students get involved in social activities and also how they interact with the outside world. There is no standard guide from which school management draw their rules and regulations from. A good indication on how formal and serious the activities are taken would be derived from the school calendar. Just a quick sample of school websites, you will find that girl's schools have a well-articulated school calendars unlike boy schools (Administrator, 2018; Admin, 2018). Furthermore, girl schools are traditionally stricter when it comes to the students interacting with the outside world. This is because of the girl retention challenge that principals in girl schools have as their number one priority (Munene, 2013; Adoyo 2016).

The above reasons will necessitate a negotiation with key stakeholders, being the ministry, the Teachers Service Commission and the school head teachers to support the platform. The parent generally leaves the care of their children to the teachers and hence trust that the teachers will make the best possible decisions in regard to the welfare of their children.

## **2.3 The Current Techniques, Models and Technologies Used in Building Location Based Systems**

Location-based services (LBS) utilizes real-time geo-data from a mobile device or smartphone to provide information, entertainment or security (Goodrich, 2013). Location-based services are a subset of context-aware services. Whereas context aware services use myriad of information to adapt and respond to user, location based services uses the location of the user only. Rouse (2016) defines context awareness as the ability of a system or system component to gather information about its environment including location at any given time and adapt behaviours accordingly. Contextual or context-aware computing uses software and hardware to automatically collect and analyze data to guide responses. Starting in the late 1990s, Location-based systems applications

resulted from the convergence of three different technologies: mobile internet access, global positioning, and advanced graphic interfaces.

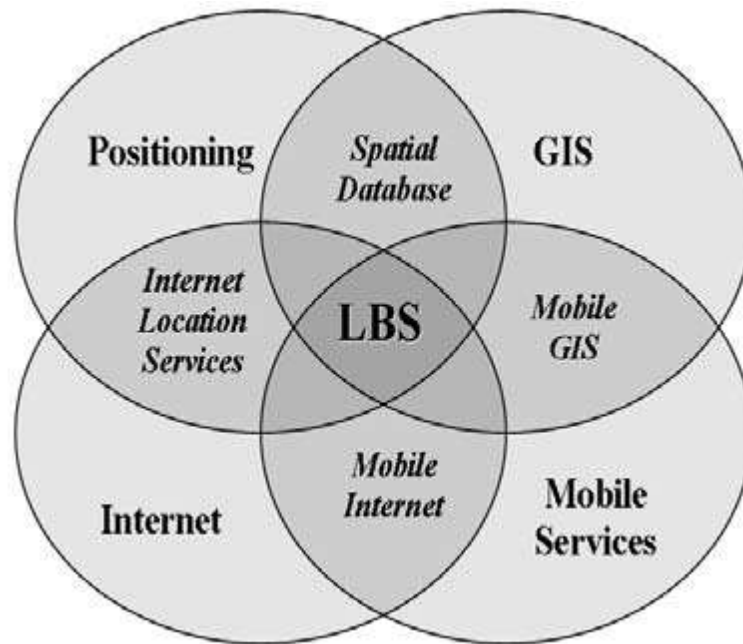
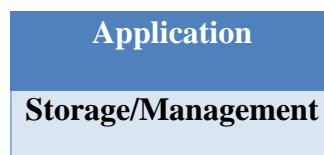


Figure 2.1 : Convergence of Technologies to Create Location Based Services (Adapted from Glezakos & Tsiligiridis, 2015)

To be able to collect the data that helps in giving the context, or in our case the location of the user, the platform must have sensors that help in collections of the data. The sensors may be classified into *physical sensors* where the Global Positioning System (GPS) sensors fall under; *Virtual Sensors*, where we calendar and emails fall under and *Logical Sensors* which are composite sensors: a combination of physical and virtual sensors (Maynard, 2014).

Figure 2.1 below shows a layered framework of the context-aware systems. At the bottom, we have the sensors like GPS. The data captured by the sensors is retrieved in the retrieval layer and pre-processed on the third layer. This data is then stored for the system application to reference during context change.



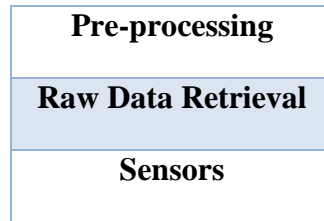


Figure 2.2: Layered Conceptual Framework for Context-aware Systems (Adapted from Maynard, 2014)

Unfortunately, the unlike context aware services, current state-of-the-art location based services are rigid as they cannot make good use of other information (Kanfade, 2018). Though context aware system maybe complicated, they are more dynamic due to a myriad of sensors and hence information they receive and thus able to adapt accordingly. With Location based systems, services are provided at inappropriate time without considering user's intention and changing environment. Also services are rigid as processing completely isolates various forms of user “preferences” (Kanfade, 2018)

The new generation LBSs are distributed mobile computing environment where the geographic locations of the users in space are used to provide context for computing and application-related optimization (Glezakos & Tsiligiridis, 2015).

Developers use feature space to come with context features that is used optimize the application. Figure 2.2, depicts a feature space detailing location of the school; and thus the school’s name and type of school (Girl school or boy school); shows the nearest suppliers and calculates the distance from the suppliers and thus cost of the delivery. The estimated time of delivery from the time of dispatch will be easy to compute thus.

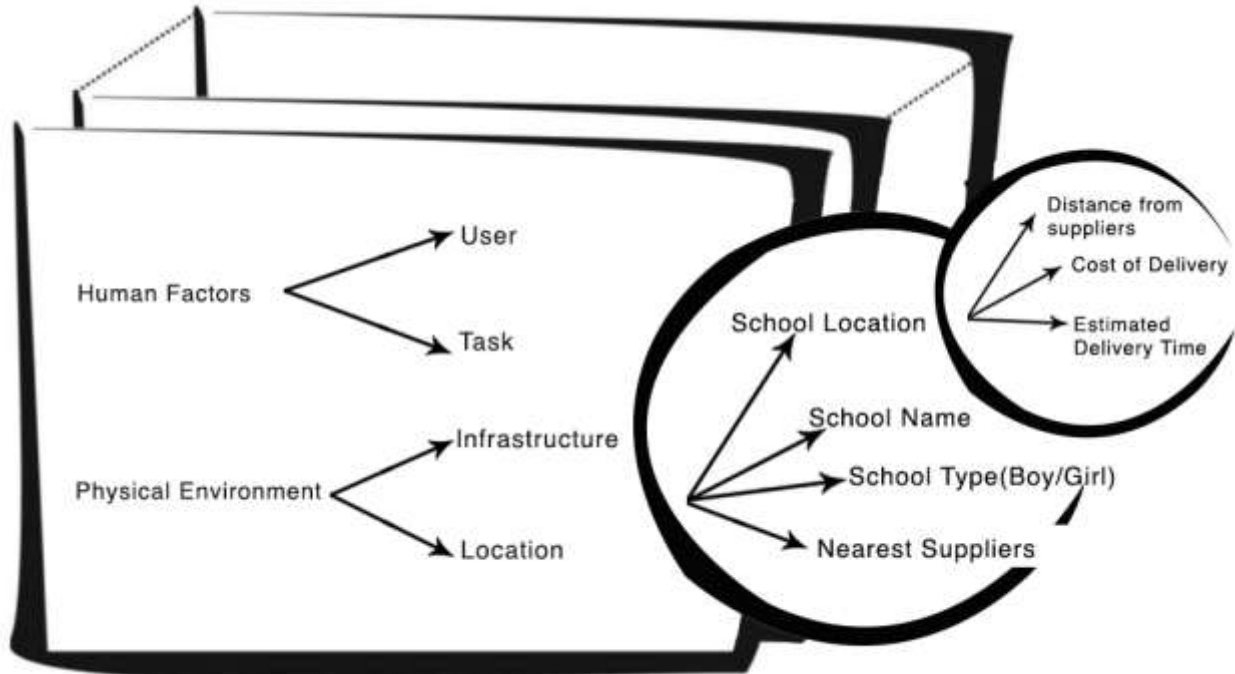


Figure 2.3 : Context Feature Space, Detailing Location as One Feature in the Conditions of the Physical Environment (Adapted from Schmidts, 2013)

### 2.3.1 Location Identification Technologies

Knowledge about the location of mobile users using mobile phone is the most basic requirement for the location based systems. The design of a system of LBSs focuses on the degree of accuracy in targeting a user's location (Pontikakos, Sambrakos, Glezakos & Tsiligiridis, 2006). There are various geo-location technologies in the market and thus the designer have to take various factors such as coverage of the technology or scalability into consideration. Table 2.1 gives the various options of location identification technologies in the market.

Table 2.1 : Location identification technologies (Adapted from Glezakos & Tsiligiridis, 2015)

Technology	Description
User Input	User enters an address
Cell (Cell Identifier)	ID The network knows which cell the handset is in. Works well in cities where cells are small.

GPS (Global Positioning System)	It based on 24-satellite network. Outdoor precision within five-meter range. User device must be in direct line of sight.
A-GPS (Assisted GPS)	Like GPS. More accurate. Enhancement over GPS. No “cold starts”. Faster fix on location.
DGPS (Differential GPS)	Similar to GPS. More accurate relative to GPS. A reference receiver computes corrections for each satellite signal received.
CoO (Cell-of-Origin)	No modifications needed to networks or handsets. Relatively low accuracy.
TDoA (Time Difference-of-Arrival.)	The network uses its base stations to triangulate a fix on the handset, based the time of arrival of signals from the handset.
E-OTD (Enhanced-Offset Time Division)	Use the triangulation technique to calculate the position. Software modified handsets needed.
ToA (Time of Arrival)	Uses existing CDMA network features.
AoA (Angle of Arrival )	Complicated antennae required.
IN (Intelligent Network)	Location Finding System independent.

The Figure 2.4 depicts the architecture of the Location based Services system. The content providers are the schools and the suppliers. The client is the delivery person, the supplier and the parent.

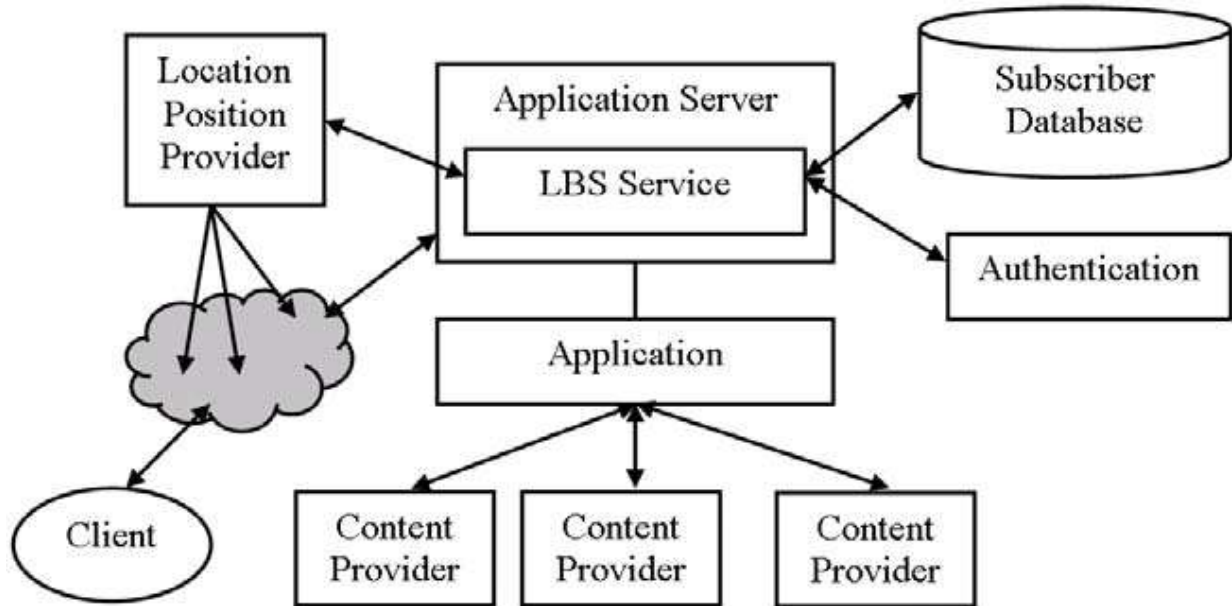


Figure 2.4 : Location Based Services Architecture (Adapted from Glezakos & Tsiligiridis, 2015)

## 2.4. Review of Similar Projects to Location based Commodity Ordering and Delivery System

Kanfade, Ambade and Bhagat in their work titled Location based Notification System uses Geospatial Database, and GIS functionality to create an android application for location reminder and friendly suggestion (Kanfade, 2018). The application works by notifying a user if they are come near 1KM of their friend. A registered shop of restaurant will set an alarm to help the user know that they are near a certain shop or restaurant. The idea is to provide a user with personalized services from the knowledge of the user’s geographical location.

Jiang and his colleagues explores the power of GPS and social media to harness Location Based Social Network. They use Location based Social Network to identify behaviour patterns and hence give users recommendations based on the analysis of the patterns (Jiang et al., n.d.) . The system uses the analysed data of user check-ins to predict the user preference and hence recommend places to the users (Katarya, Ranjan & Verma, 2016).

Kulkarni and his colleagues on their work Location Based Advertising System (Kulkarni & Pi, 2018), explores the use of open source embedded Raspberry Pi platform integrated with the Global

Positioning system (GPS) for its primary application in public transportation system by implementing a real time advertising system based on geographic location of user. They dab the system Targeted Mobile Advertising System (TMAS), a platform that aims at linking merchants and consumers (mobile phone users) and uses personalization and pull approach to deliver targeted advertisements (Kulkarni & Pi, 2018).

Liu and Xie (2015), did a research on *Preparation and scheduling system of emergency supplies in disasters*. The purpose of the research was to find a system that will help with scheduling so as the supplies to reach the disaster areas in the shortest time possible. The focus was on the preparation process and scheduling process to coordinate well so that the supplies arrive in a disaster point in time. The paper proposes a simplified simulation system of emergency supplies preparation and scheduling which can be employed in actual emergency response.

The research by Liu & Xie (2015) is similar to our research in terms of ensuring that supplies are delivered to the requested school and hence the student in the shortest time possible. In school, the supplies will vary from the normal food stuff like juice and biscuits to more essentials supplies like a set book, pullover or a blanket. We have had cases of students going to school with all the requirements only for the essentials to be stolen in less than a week. We have also had students get to school expecting summer only to have the worst winter ever registered. In such cases, students would want the heaviest blanket or new jumpers or heavy blazers in the shortest time possible.

Koross, Ngware and Sang (2009) investigated the contribution of parents to the financial management of secondary schools and if this contribution in the financial management would reduce challenges such lack of transparency especially in financial accountability leading school fee hikes. The findings were as quoted below:

*“The findings of this study indicated that Principals and students perceived parental involvement in financial management as present to some degree in most schools. The results also indicated that parental involvement had positive influence on financial management outcomes. Since schools’ finance is critical in school management outcomes, it is therefore important for education stakeholders to increase parental involvement.”* (Koross, Ngware & Sang, 2009).

The above research shows the importance of parental involvement in matters of schools and students who are their children. By parents being included in the workflow of our platform the,

parent will be able to be more engaged in their students' studies and even keep tabs of how their children are using the resources that they provide them. The system will be able to print out reports of order by a particular parent for a particular student for periods ranging from one year, to four years or even per term. In this manner, the parent can start teaching their children a sense of responsibility by making them account to supplies they were bought for if the parent deems that there has been a wastage of resources by the child.

## 2.5 Location and Context based Platforms

### 2.5.1 Sendy

Sendy is delivery platform that help users make delivery from point A to point B at the touch of a button. Sendy works by a user making a request via mobile application or through a website and on a push of a button and a driver comes to the user in less than hour. Sendy started as a bike delivery company and now they own vans and trucks (Sendy, 2018). Sendy has the commodity getting delivered insured such that if something should happen to the commodity, whatever it's, the user will be compensated fully.

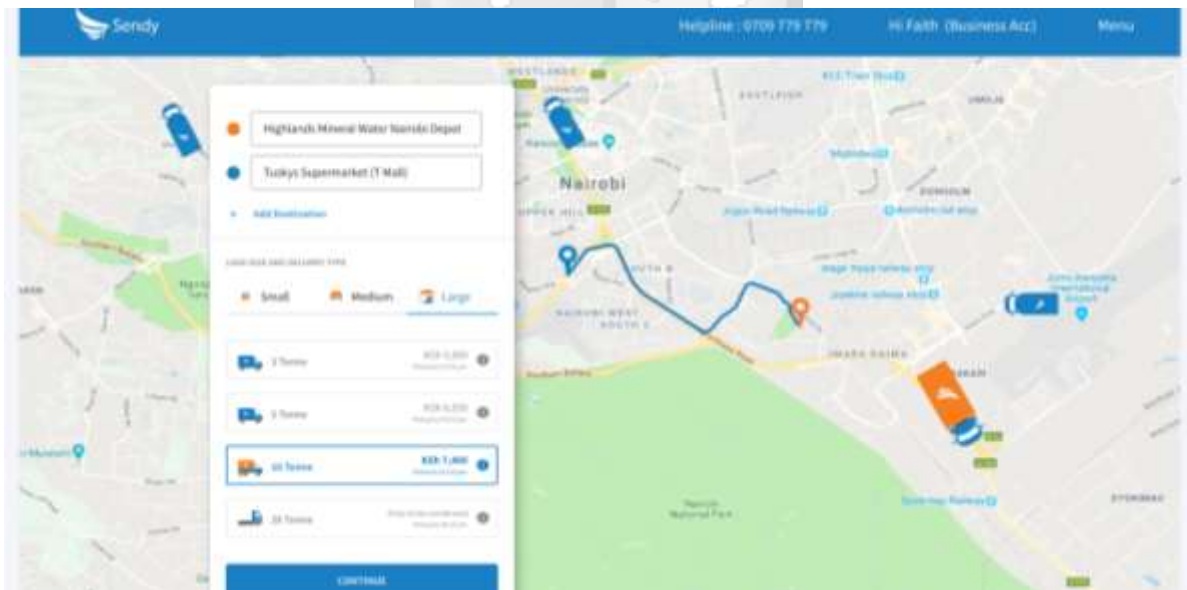


Figure 2.5 : Web Interface of the Sendy Platform (Adapted from Sendy 2018)

The Location-Based Commodity Ordering and Delivery System: Case of Boarding Schools in Nairobi borrows from the Sendy concept of delivery of errands by way of motorbikes. However, the location based system is country wide, and not only based in cities or towns. The commodity Delivery system is implemented in a way that the requester is not the person who will make the payment. The person making the payment is in control to edit approve or disapprove an order. There is an oversight user who keeps tabs with all the request to ensure that there are no illegal commodities that has been ordered. Another, aspect that Sendy does not have or need is the fact that the does not need to be trust between the delivery person and the customer. On the location based system, the delivery person must be vetted and they must be some level of trust between them and the school

### **2.5.2 Uber**

Uber started as a taxi hailing mobile application that helped users hail taxi faster. The application was able to calculate a fair cost for the rider and the taxi hence doing away with extortion of riders by the taxis. In addition to helping users get from point A to point B, Uber have been working to bring the future closer with self-driving technology and urban air transport, helping people order food quickly and affordably, removing barriers to healthcare, creating new freight-booking solutions, and helping companies provide a seamless employee travel experience (Uber, 2019).

The Location-Based Commodity Ordering and Delivery System borrows the matrix of the proximity to a location from Uber application. The system checks to confirm the closest supplier to the school who will receive the request. This is to cut on time taken to deliver and the cost of delivery. The matrix also searches for the closest delivery person to the supplier to make delivery to school. The two applications defer on the point of Uber is a taxi application of transportation purposes, while commodity delivery is for delivery of commodity to customers who initiated the request but did not pay for the order, a second party did.

In this context, the provision for previous orders module also give the parent an insight on the usage of the students, the pattern and sequence of their children requests and hence their usage.

The parent gets a notification when the student receives the order and hence is sure that the commodity reached its intended recipient before the payment is made to the supplier. The system therefore removes the issue of students not receiving items sent to them by the parents.

### **2.5.3 CarreFour**

Carrefour an internal store, that recently opened stores in Kenya have service on their website where users can locate the Carrefour store that is nearest to where they currently are. At a click of button, the website uses Geospatial location of the user to give the user options of the stores that are closest to the user. Users are able to make orders online and have the commodity delivered through the home delivery service of the store. The user is requested to keep the original delivery notes as it is the proof of purchase (Carrefour, 2019).

Carrefour's signed a partnership agreement with online retailer Jumia to offer online shopping in Kenya as from January 2019. Carrefour with six outlets since its operations were launched in Kenya in 2016 decided to partner with Jumia to offer their products to more Kenyans (Reuters, 2018). Shoppers will enjoy the same great value prices and quality of products they enjoy at Carrefour stores. This comes with the added assurance of Jumia's buyer protection policy, country-wide delivery, seven-day free returns and varied payment options including cash on delivery, mobile money and credit card (Capital, 2018).

The Location-Based Commodity Ordering and Delivery System has one fundamental difference with Carrefour and Jumia platforms: The person who request an order is not the person who pays and the person who pays is in control of the entire purchase process. This helps with control in the school context. The locator of Carrefour broadcasts the shop location vis a vis that of the customer while the Commodity Delivery System broadcast the location of the shop vis a vis that of the school

### **2.5.4 High schools Embracing Technology**

More schools in Kenya are embracing technology than ever before. Due to a wave of arson, violence and case of student missing from schools in the recent years, many schools have turned to technology to help them curb the situation and instil discipline among students (Nyabwa, 2018).

#### **2.5.4.1 Biometric Sign-in in Schools**

Schools like state house girl have installed biometric sign in where student sign when they report to school and sign out when they leave for school holidays. A text message is sent to their parents notifying them that their children have arrived or left school. For day schools such as Jamhuri high school, student login when they come to school in the morning and checkout when they are leaving in the evening. In both cases, their parents receive text messages (Nyawira, 2017).

In a school such as Karima Boys High school, the school accountant uses biometric automatic teller machine which requires a student's thumbprints and personal identification number to make a withdrawal. Immediately a withdrawal is made, an SMS is sent to the student's parents or guardians notifying them how much has been withdrawn (Nyawira, 2017).

#### **2.5.4.2 CCTV Cameras in Schools**

The schools also have taken up the issue of monitoring student through the use of CCTV cameras installed in various strategic places in the compound. At the laboratories, the CCTV ensure that students do not take out chemicals that could be potentially dangerous (Nyawira, 2017).

### **2.6 Value Proposition**

The location-based commodity ordering and delivery system will enable parents to order commodity by press of button for students who are in boarding school miles away from the parent and the commodity be delivered in timely manner to the student in school, without the parent calling relative or friend to help deliver a commodity to the student. The system enables the parent be in charge of the order request made by the student be able to validate before approving the order.

The value proposition of the system to the commodity suppliers is the potential of online customers in boarding schools; a new niche for the suppliers. The fact that suppliers are able to sell their products to boarding school's customers at a tap of a button, hence saving the establishment thousands of shilling on marketing.

## 2.7 Conceptual Framework/Proposed Architecture

Figure 2.5 shows the conceptual framework of the Location-Based Commodity Ordering and Delivery System: Case of Boarding Schools in Nairobi. The platform structure is in a form of a workflow: The student makes a request of the commodities that they need in the school; the request is sent to the parent who verifies the commodities and edits to add or remove a product accordingly; If satisfied, the parent confirms the order by authorizing and committing payment for the delivery; the supplier who is located by the matrix to be the closest to the school dispatches the requested commodity to the school after assigning a delivery person who is located to be the closest to the supplier.

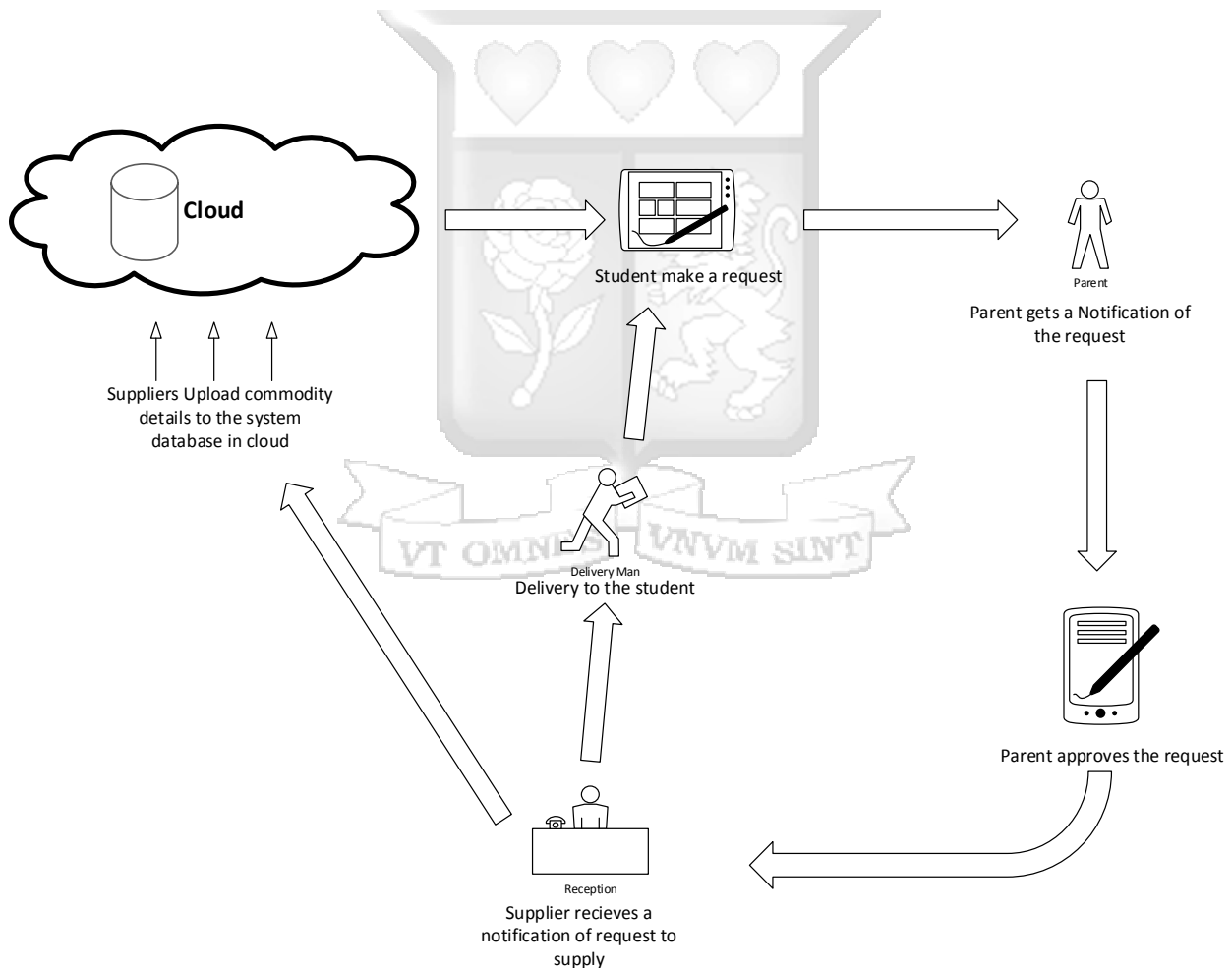


Figure 2.6: Conceptual Framework of the Service Delivery Platform

## **Chapter 3 : Research Methodology**

### **3.1. Introduction**

This chapter established ways and means in which project objectives are investigated to guide the approach of tackling the problem at hand. The chapter endeavours to lay out a blueprint that includes collection, measurement, and analysis of data; the overall objective being: to develop a location based commodity ordering and delivery system that will streamline delivery of commodities to students in boarding schools and bring the parents a sense of peace and surety.

The key stakeholders in this work includes but not limited to: boarding schools, boarding students, the government with respect to the Ministry of Education, the parents and the strategic outlet (supermarkets) or suppliers as referred to in this work. The aim of this chapter was to get a balanced feedback that is not skewed; the data that is to inform the tailoring of the system in a way that meets the needs of all the actors in the most efficient, effective and intuitive way possible.

### **3.2 Research Design**

In this study, exploratory research style is used to carry out a qualitative research. The focus on this study being the analysis of various factors relating to commodity ordering and delivery in schools. Yin (2006) defines an exploratory as a "valuable means of finding out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light." According to Brancato et al. (2004) in this kind of work, the researcher focuses on a search on literature, talking to experts on the subject matter and conducting focus group interviews. The project is a complex one needing the balance of views from various stakeholders. Those who engage in qualitative form of inquiry support a way of looking at research that honors an inductive style, a focus on individual meaning, and the importance of rendering the complexity of a situation (Creswell, 2014).

This research design was preferred over the traditional survey because the objectives of the study required an in-depth understanding of the impact of commodity delivery to schools; students

contact with the outside world; the communication channels that students have with their parents though controlled; parents trusting third party they have never met to deliver commodity to their children and government trusting the administrators of the system not to abuse the data and the privilege of access to schools. The study documents the challenges that the project faced in terms of government policies and various school rules. According to Silverman & Marvasti (2008) in their citation of Denzin and Lincoln (2011), “qualitative investigators, think they can get closer to the actor's perspective through detailed interviewing and observation”. The focus groups were also constituted from the platform users such as the parents and students; the school administrators; and the government.

The project employed structured interviews that strived to find how various respondents responded to the same question. This was to find if they had a different preference, a difference challenge or if they had different views with respect to the commodity delivery system. This came in handy when interviewing the parents and the school administrators.

### **3.3 Agile Software Development Methodology**

Agile means, to be able to move quickly and easily. As the meaning suggests, it is a fast way to build a mobile app or software as compared to the traditional ‘waterfall’ method (Skylarksg, 2016). Abrahamsson, et al. (2004) defines agile development method as an incremental (multiple releases), cooperative (a strong cooperation between developer and client), straightforward (easy to understand and modify) and adaptive (allowing for frequent changes).

This approach enables requirements and solutions to evolve through the combined effort of the system developer’s team and the stakeholders/customers. Agile enhances adaptive planning, evolutionary development, early delivery and continuous improvements. It is an iterative and flexible approach is perfect for complex projects where the customer requirements change frequently just as is in mobile development. With agile, a big project can be broken down into smaller parts and agile methodology can be applied to each of these small parts. As this method requires high stakeholder engagement, so as to take in the stakeholder’s requirements at each step and their feedback after every step into account (Queppelin, 2016). Figure 3.1 depicts the agile methodology various sections in three sprint format.

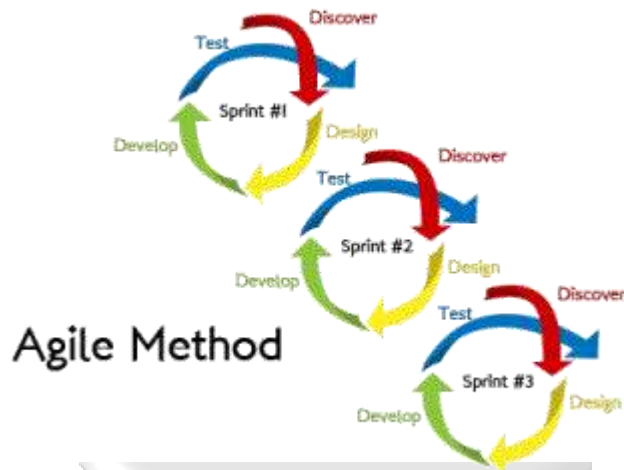


Figure 3.1: Agile Methodology (Adapted from Queppelin, 2016)

The project employed agile methodology by breaking the system into three initial phases. The identification of the system requirements that informs the module that the system ought to have. This was achieved via analysis of the data received from the questionnaires. Wire-framing phase was the second phase where the modules identified were laid down per user.

The development phase was further decomposed to database development, the web application development, the User Interface development, API development and the mobile application development. The web application development took most of the time and resources as it had to be developed with an API in mind for the development of the mobile application.

With a vibrant web application in place it was easier to develop the API and the mobile applications

### 3.3.1. Planning Phase

The project started with compilation of a list requirements from the key stakeholders by way of collecting data from the stakeholders. As mentioned earlier the project made use of focus groups and interviews through questionnaires to collect the data. The project did set a side four weeks for the purposes of collecting the data from the sample size that is given in the coming sections. The collections of data was the phase that dragged the project a bit, given that during the third term no outsiders were allowed to access school to avert possibility of exam cheating.

The resulting requirements after the collection of data and analysis of the same, informed the size of the modules and the depth/detail that each module would be. It was after this that the project looked into whether a module needed to be decomposed further for ease of development. The major system requirements were established and listed. How modules interrelate and communicate were established by how the data flows through the system. This was established by designing the system; by employing context diagrams, use case diagrams, sequence diagrams data flow diagrams and entity relationship diagrams. The project allocated two weeks for this.

The project then developed the database and ensured all the dependencies were captured. This was given three weeks. System development and the API integration was allocated eight weeks. The Gantt chart shown on Appendix A depicts the timelines of the project

### **3.3.2 Requirements Analysis Phase**

Following the focus group discussion with school administrators and the interviews results of students and parents, the project classified the responses in terms of essential functionalities and none-essential functionalities that the platform was modelled towards. The functionalities informed the modules that the system needed to have and the nice to have modules, as well as the hardware needs of the system such as the GPS receiver, how fast the processor needs to be and how much memory was needed for the system to respond effectively and efficiently.

The proposed platform was highly goal driven; by no means was the system in anyway intended for leisure purposes, but for serious purpose of solving a downstream delivery challenge in boarding schools. The extent of further system categorization was informed by again, the results that the project was able to get from focus groups and from the interviews. The analysis of the feedback informed the project on the kind of information that the system stored, which of this information was extremely sensitive as indicated by the population.

The analysis of the feedback informed the user experience that the population expect. Though many users do not know the kind of user experience they want until they actually experience it, some guidance on how they would like the system to respond and how the human computer interaction (HCI) should be, was helpful. For instance, it was great to get insight on whether the parents would like to make the payment of the commodity before delivery is done or after the

delivery is made and confirmation is sent. It was also be interesting to note how they wanted the platform to implement commodity delivery confirmation; with most parents wanting their children to make confirmation.

On developer's flipside, the concern was on mobile devices being ran by various operating systems and development platforms that have posed challenges in building applications in terms of various aspects like development cost, development technology, skilled people, learning curve of the developers (Gondhali, 2014). This project was no different; the development of front-end involve trade-offs of whether to use platform-specific, cross-platform or hybrid development (Noller, 2014; Typing, 2017). Due to the fact that we are looking at a service that is new to the market and hence need to convince the users to take up the service, the project had to weigh the challenges that come with cross-platform development or hybrid (Perchat, Desertot & Lecomte, 2013) or the challenges of not having the mobile application accessible to all mobile users.

The project decided on going the hybrid way, by employing Ionic framework. This way, the project was able have the mobile application accessed across major mobile platforms with a consistent user experience across multiple mobile platforms. Users expect the application to be instantly responsive on different devices and deliver a glitch-free experience. And while it displays data faster and adjusts to different device screen configurations immediately, it also resolves the issues of the fluctuating data streaming capabilities (Rishabh, 2017). The project gave users option of visiting the application via web browser by developing a responsive web application that is able to run in multiple browsers.

### **3.3.2.1. Location of the Study**

This study took place in Nairobi County, the location of the capital city of Kenya, Nairobi. The total number from the above statics puts the number of secondary schools in Nairobi at 162 schools. Report on the statistics of basic education done by Ministry of education in conjunction with UNICEF (Education, 2014) puts the number of public secondary schools at 77 with private secondary school being recorded as 158 in number. This puts the total number of secondary schools in Nairobi at 235. Table 3.1 shows the number of boarding schools, day's schools and mixed schools in Nairobi County. The total number of boarding secondary schools in Nairobi is 143 (Education, 2014).

Table 3.1: Number of Schools in Nairobi County by Accommodation Status (Adapted from Education, 2014)

County	Public			Private			Total		
	Day	Boarding	Day & Boarding	Day	Boarding	Day & Boarding	Day	Boarding	Day & Boarding
<b>Nairobi</b>	26	38	13	13	105	29	39	143	42

### 3.3.2.2. Target Population

Sharp and his colleagues does a thorough job in identification of stakeholders of a system (Sharp, Finkelstein, & Galal, 1999). The authors start the process by identifying “baseline” stakeholders of two types: “supplier” and “client”. Suppliers are the information and tasks contributors, while clients the product inspectors. The “satellite” stakeholder is a broader category of stakeholders, which cooperate with the baseline stakeholder in number of various ways. The approach focuses on the interaction between these stakeholder categories.

Supplier stakeholders include the commodity suppliers; by updating the stock information and giving information on dispatch of delivery. Client stakeholders include the students and the parents; by making use of the stock in system, requesting for the services through the system and making payment through the system. The satellite stakeholders include the government and the school; by way of having limited access to the system that enables them to generate reports and use the system send out emails to parents.

This paper focusses on four key stakeholders in the development of the location-based commodity ordering and delivery system: case of boarding schools in Nairobi. Figure 3.4 shows the four main stakeholders of the platform.



Figure 3.2 : Stakeholders for the Proposed Platform

- I. ***Parents/Guardians:*** Parents are the most important piece in this puzzle. They are the main users of the system. The project held conversation on what would make the system be user friendly to them, get their feedback on any fears of the system if any. The project sought to get any value addition service that can be bundled together in the system.
- II. ***Students:*** Students are another important pillar of the system. Without them, the system is not needed in the first place. The conversation was about what will work for them, what they want to see in the system, what services are key and how they would like to interact with the system.
- III. ***School Administrators and Teachers:*** The fact that to deliver commodities successfully the students will have to have contact with the outside world, the school administrator must be fully on board and in support of the system. This is for a number of reasons; the contact with outside world can compromise the students by establishing a route of getting drugs into school; help in cheating by bringing in un-authorized materials for students and so on. As such schools have different policies to handle interaction with the outside world

IV. **Commodity Suppliers:** The suppliers have to understand the importance of the service to them as well. The project has to communicate the incentive that the commodity suppliers will receive for being part of the stakeholders

The scope of this study narrowed down to three main categories of the population; school administrators, parents of boarding school students and the students.

### **3.3.2.3. Sample Size**

Elimu (2018) puts the number of public secondary schools in Nairobi at 52 schools. The county government of Nairobi puts the number of private secondary schools at 110 secondary schools in Nairobi (Nairobi, 2018). The total number from the above statistics puts the number of secondary schools in Nairobi at 162 schools. Ministry of education puts the total number of secondary schools in Nairobi at 235 (Education, 2014) with boarding schools being 143 in number.

According to Mugenda and Mugenda (2003), a sample of 10-30% is believed to be adequate for a study. Going with the above formula, the study targeted to work with at least 14 boarding secondary schools. The project strived to have a focus group discussion of the administrators from these schools and mix it with a structured interview to get a detailed perspective of school rules and regulations that some administrators did not want to share openly during the focus group discussions.

Ministry of Education puts the total enrolment in Nairobi in 2014 at 69,934 as shown in the table. The project targeted to interview at least one student and one parent from the 14 schools that were studied as identified in the above paragraph. The uphill task for the project was getting an audience with government ministries and interview the either Principal Secretaries or Cabinet Secretaries. The project was however not successful in scheduling an appointment with any of the two secretary cabinets.

Table 3.2: Secondary Schools Enrollment by School Status in Nairobi County (Adapted from Education, 2014)

County	Schools			Enrollment		
	Public	Private	Total	Public	Private	Total
Nairobi	77	158	235	44,981	24,953	69,934

### 3.3.2.4 Testing of the Prototype

The project employed non-probabilistic sampling methods in picking the schools, parents to use in the testing of the system. Convenience sampling (also called Haphazard Sampling or Accidental Sampling) is one type of nonprobability or non-random sampling that was used. This is where members of the target population that meet certain practical criteria, such as willingness to participate, geographical proximity or availability at a given time are included for the purpose of the study (Etikan, 2017). Convenience sampling was used in picking the schools in Nairobi County for the purpose of the study.

Purposive sampling technique another one of the non-probabilistic sampling methods, also called judgment sampling, is the deliberate choice of a participant due to the qualities the participant possesses (Etikan, 2017). Purposive sampling was used to sample parents who students are in boarding schools in Nairobi County.

As earlier mentioned, there are 143 boarding schools in Nairobi country. Mugenda and Mugenda (2003) writes that 10-30% of the total population is believed to be adequate for a study. The test therefore targeted 14 boarding schools in Nairobi.

### 3.3.2.4. Data Collection

During the focus group discussions tapes were ran to record the conversation and views of the various stakeholders, especially the government, and the school administrators. The project also employed taking of notes as reference points while compiling the feedback. Structured interviews were mainly used to collect data from parents and students to see how they answer to the same questions hence try to find preferences in terms of the system functionalities. The idea was to

develop an interview schedule which will list the wording and sequencing of questions to increase the reliability and credibility of the research data.

### **3.3.2.5. Data Analysis**

The analysis process was divided into three key sections:

#### **a). Developing and Applying Codes**

Codes which may be words or short phrases were developed to represent an idea for the application or module/functionality for the application. The codes were assigned meaningful titles. A wide range of non-quantifiable elements such as preferences, school rules, activities, policies were coded.

#### **b). Identifying themes, patterns and relationships**

The project strived to identify common themes, patterns and relationships within responses of sample group members in relation to codes that had been specified. Techniques that we employed included:

- I. ***Word and phrase repetitions*** – scanning primary data for words and phrases most commonly used by respondents, as well as, words and phrases used with unusual emotions;
- II. ***Primary and secondary data comparisons*** – comparing the findings of interview/focus group/observation/any other qualitative data collection method with the findings of literature review and discussing differences between them;
- III. ***Search for missing information*** – discussions about which aspects of the issue was not mentioned by respondents, although you expected them to be mentioned (Methodology, 2018).

#### **c). Summarizing the data**

The project linked research findings to hypotheses or research aim and objectives. Noteworthy quotations from the transcript were used in order to highlight major themes within findings and possible contradictions.

### 3.3.3 Design Phase

The design and development of the proposed system was divided into two main parts:

#### i) **Back-end (Web API & Server)**

The engine of the application is sitting in the cloud server at Linode VPS services. The project employed the below technologies:

- a. **Language** – The project employed Java, JavaScript and PHP to build the API.
- b. **Database** – The project employed a traditional SQL type of database with the implementation of MariaDB.
- c. **Hosting Environment (Infrastructure)** – With the hosting costs, scalability, performance, and reliability of the application in mind the project employed Linode Cloud VPS services. Its services which are cloud-based solutions allow for payment of resources as a utility and scale up and down as needed. They also help with database backups, server uptime, and operating system updates.

#### ii) **The Front-end (The mobile application and the web application)**

The project employed *hybrid mobile application development* approach to give a consistent user experience across multiple mobile platforms. Users expect the mobile application to be instantly responsive on different devices and deliver a glitch-free experience. While hybrid application displays data faster and adjusts to different device screen configurations immediately, it also resolves the issues of the fluctuating data streaming capabilities. Being lightweight, the hybrid application User Interface can also load the high-definition graphics and content quickly (Rishabh, 2017).

The project was developed for cross-platform mobile development hence Ionic open source framework was used in this project. The User Interface looked entirely native and the application is fully optimized for different environments thanks to Apache Cordova. Hybrid applications take advantage of each platform's libraries or user interface components like buttons, lists, and so on. One of these components is web view—a view that displays web pages. This is a native mobile application component that can run a web application. A mobile application can be written in

HTML, CSS, and JavaScript and be displayed by using a web view. Ionic uses the Apache Cordova project to build and run mobile applications as native applications (Munyaka, 2019). Cordova acts as a bridge to native code for Ionic. It compiles HTML, JavaScript, and CSS into native applications, enabling them to run natively on Android, iOS, and Windows Phone devices.

**iii) User Interface**

The goal of the user interface design is to facilitate the user-application interactivity and to increase the effectiveness of the user’s work (Georgiev & Georgieva, 2009). The user interface design is greatly affected by the screen size in question. For a web-based application, this is easy to solve, by employing media query attributes of the Cascading style sheet (CSS). This will result to a responsive website that detects the screen size of the gadget and picks the CSS that is relevant for this particular gadget screen size. Figure 3.5 shows the main mobile devices main screen resolutions in market at the moment.

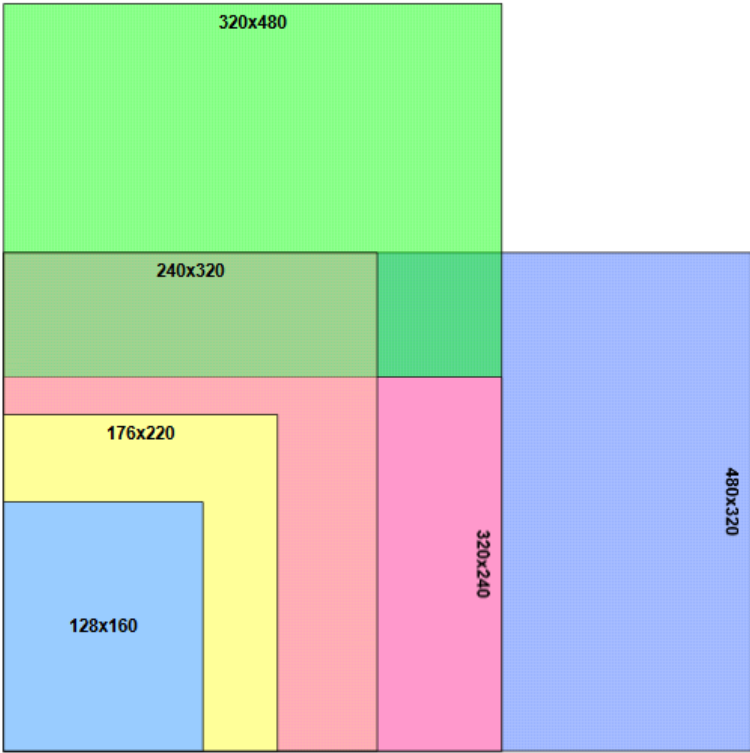


Figure 3.3: Mobile Devices Main Screen Resolutions (Adapted from Georgiev & Georgieva, 2009)

Hybrid mobile application development displays data faster and adjusts to different device screen configurations immediately, it also resolves the issues of the fluctuating data streaming capabilities (Rishabh, 2017). The orientation of the screen should be taken into account, as most of mobile devices still work in a vertical mode and they cannot display text in several columns. It is recommended that the navigation scheme support two fields with navigation - at the top and bottom of the screen and the information is visualised between them as shown in the Figure 3.6 (Georgiev & Georgieva, 2009).

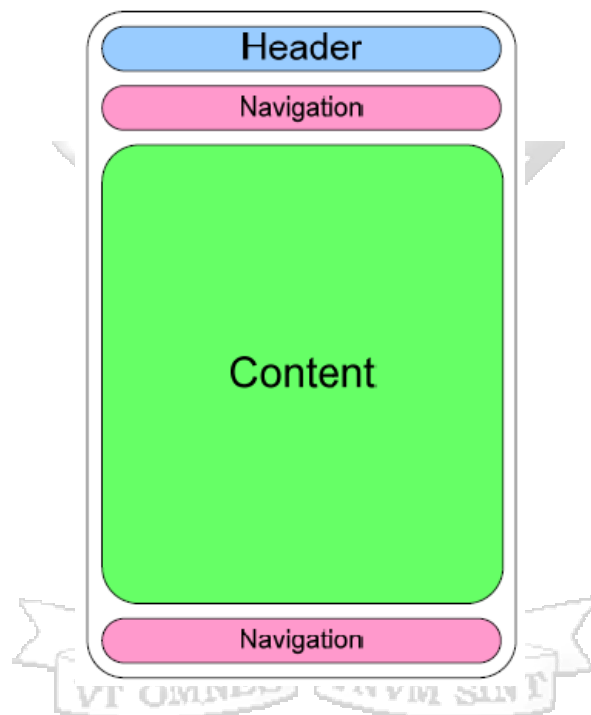


Figure 3.4: Mobile Devices Navigational Schemes (Adapted from Georgiev & Georgieva, 2009)

### 3.3.4 Development Phase

The mobile application market is growing tremendously, with most of the work that were a research of personal computers being executed in the mobile handset (Whitwam, 2016; Titcomb, 2016). This can be attributed to the growing performance power and the utilization of the network resources by the mobile handset thus offering a strong alternative to workstations (Spataru, 2010).

Software development for mobile platforms is not different from any other system development though it comes with unique challenges. Some the distinguishing characteristics are identified in include: a high level of competitiveness and necessarily short time-to-delivery; (Abrahamsson, et al., 2004). Developers must face the challenge of a dynamic environment, with frequent modifications in customer needs and expectations. Mobile development come with unique technological constraints (Abrahamsson, 2007) in the form of limited physical resources and rapidly changing specifications. This is not to mention a variety of devices, each with particular hardware characteristics, firmware and operating systems.

Hayes in his work expounds on two types of constraints; evolving and inherent (Hayes, 2003). Evolving constraints, such as bandwidth, coverage and security, currently apply to the mobile technology, but the author argues that these are likely to be solved in the near future. On the other hand, inherent constraints such as limited screen real estate, reduced data entry capability (due to a limited keypad for example), memory capacity, processing power and limited power reserve, are permanent, at least relative to desktop environments. Various approaches must be used in order to lower the impact of inherent constraints (Spataru, 2010).

Due to the uniqueness of mobile development, a suitable development methodology should be chosen. This work employed agile development methodology for the development of the platform.

### **3.3.5 Prototype Evaluation and Testing**

The project used hybrid application development to develop the front end of the mobile application. This is because the project needed the application to be accessed by users from different mobile platforms. The project therefore used Ionic framework in the development of the hybrid application. Ionic uses Cordova project to build and run your apps as native apps. The responsive website was developed in HTML5, PHP, CSS 3 and JavaScript which took advantage of the most current html tags and CSS attributes.

The system runs on MariaDB database which is hosted on the cloud VPS. The project employs Linode cloud VPS hosting services which provide services which users pay as utility. This way the project only pay for what it uses and scalability is not an issue as well with Linode cloud.

The backend is developed in Java, JavaScript and PHP where there is a need. Where there is a need, the project employs JSON instead of XML as JSON is more robust than XML in communication between client-side and web server.

### 3.3.5.1 System Testing

As mentioned above, the project employed a test intensive approach where each phase is extensively tested and updated by the developers before development proceed to the next phase. But most of this testing was done by the stakeholders. However, experience teaches that in ideal world, the systems attracts interest from across the board and hence the need for a window specifically for testing not only for the stakeholders but also from the various interest groups. Most testing were performed by non-developers and/or individuals were not the application's primary developer. This helped ensure a more genuine testing experience. The various testing for the mobile application followed the below strategy. Altexsoft (2019), explores the following categories of testing:

- I. **Functional Testing** – The project was tested for the functionality requirements that was be identified in chapter four of this work. The functionality requirements are informed by objectives of developing the application or the problem the application is intended to solve.
- II. **Usability Testing** – The project ran this test to ensure the myriad of stakeholders of the platform who cut across from the educated to the non-educated; from the tech-savvy to the none-tech-savvy were comfortable with using the system. The application was to be intuitive enough and user-friendly to meet the largest portion of the stakeholders.
- III. **Performance Testing** – The project tested for usability of the application by looking at the response time of the system or utilization of the hardware resources.
- IV. **Regression Testing** – A final test to ensure all the modules work and respond fine while synchronized and working as a unit.
- V. **Compatibility Testing** – The platform was tested in various hardware's and software's with various screen ratios to ensure that user experience was kept at high standards in many of the hardware's as possible.

### **3.3.6 Ethical Issues**

The system is collecting very crucial data about students. This prompted the project to seek approval from National Commission for Science, Technology and Innovation (NACOSTI) whose mandate is to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto. Among other functions of body, the body accredit research institutes and approve all scientific research in Kenya; and promote increased awareness, knowledge and information of research system. The approval was granted on 6th of July 2017 with a green light to collect the data from participants.

Among the participants that were targeted by the study included large number students who were under the age of 18 or just there about. Children are a delicate topic and should be handled with care. The paper is dealing with individuals who cannot make decisions of their own but depends on their caregivers to makes decisions for them. As such we ensured that all our study subjects had given consent through their caregivers and there that was no child who was considered in the study without prior consent from the caregiver. No confidential information of the child was given out to any agency or the public.

The system also collected data about the parents and their private data such as email address and mobile numbers. This information cannot be shared with anyone or any institution without prior written and signed consent of the owner of the data. From time to time, school administrator shall also communicate some critical information about the strategies on handling certain aspects of the student life. This information cannot be shared with any other school or institution whatsoever.

## **Chapter 4 : System Design and Architecture**

### **4.1. Introduction**

This chapter presents the detail description of the technical aspects of how the context-aware commodity ordering and delivery system is developed. Detailed considerations are made on the various contexts that the system needs to be aware of; the functional requirements, the non-functional requirements, the nice to have requirements; the data sets of the various models and how they interact. According to (Dustdar, 2005), software architectures typically include the description of components, connectors, and configurations. For this reason, it is important to decompose a system into a well-defined set of components that have clear responsibilities. Waldo (2006) notes that designing a system requires that someone thinks about the right way to decompose the functionality, and how to create a small set of abstractions that can be re-used and re-combined to provide the needed functionality.

This chapter therefore breaks down the system into smaller abstractions that can be solved as units that later are brought together to interact with each other and provide the service that is required of context-aware commodity ordering and delivery system.

### **4.2. Data Analysis**

The data collection for this study was done using both interviews and questionnaires. The questionnaire was presented on printed forms that the participants could record their responses. Interviews were conducted on a one on one basis with school administrators, boarding school students and parents of boarding school students. 20 school administrators, students and parents took part in the interviews and filling of the questionnaires.

Questionnaires were used to find out about the current processes/systems, their limitations, users' expectations of the new system and to determine the number of people who would like to use the system and think it is a good idea. The findings of the questionnaire informed the functional requirements of the proposed system.

#### **4.2.1 Degree of Response**

The target population comprised of boarding school students, parents of boarding school students and boarding school administrators. The study was able surpass the target of 14 school administrators, 14 students and 14 parents by managing to interview and get responses from 20 respondents representing each of the three target groups. Participants were interviewed, and responses were collected in questionnaires that were developed for each set of the targeted population. There was a questionnaire for parents, students and school administrators. The following feedback were compiled from the questionnaires.

#### **4.2.2 Parents of Boarding School Students**

##### **4.2.2.1 Children in Boarding Schools**

The question was meant to find out an average of number children that parents have in boarding school (primary and secondary). 44% percentage of the respondents had only one child in boarding school. Figure 4.1 depicts the responses to the number of children in boarding schools represented on a pie chat by way of percentages.

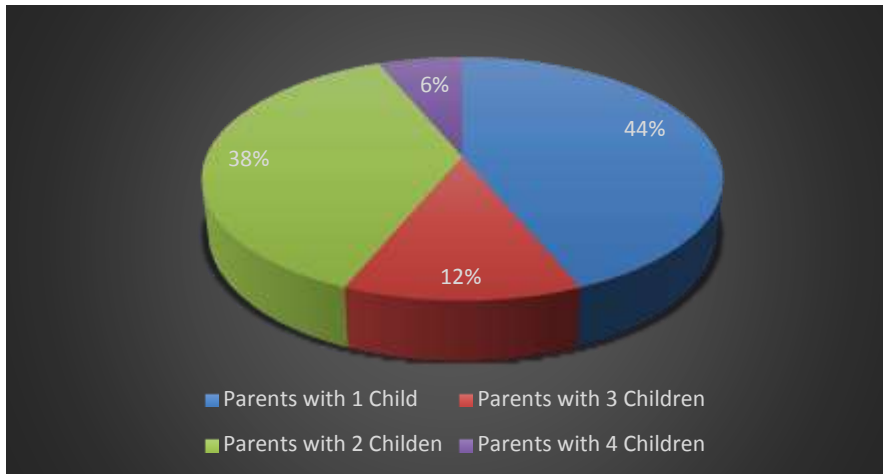


Figure 4.1 : Number of Children a Parent has in Boarding Schools

#### 4.2.2.2 Children in Secondary Boarding Schools

The question was meant to find out an average of number children that parents have in boarding schools but at secondary level. 76% of parents have only one child in secondary level boarding school. Figure 4.2 depicts the responses to the number of children in boarding schools at secondary level represented on a pie chat by way of percentages.

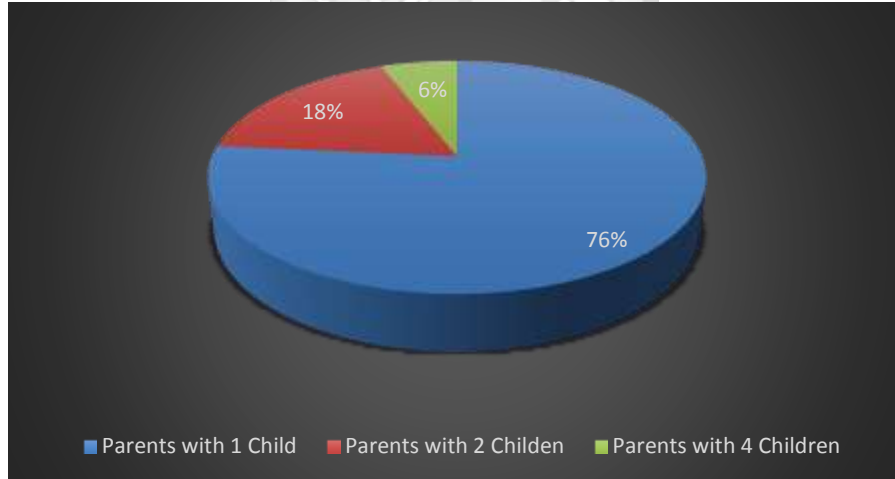


Figure 4.2 : Number of Children a Parent has in Boarding Schools at Secondary Level

#### 4.2.2.3 Public or Private School

The question was meant to seek whether the parents enrolled their children in public or private boarding schools. 73% of the parents have their children enrolled in public boarding schools.

Figure 4.3 depicts the responses to the type of school; public or private represented on a pie chat by way of percentages.

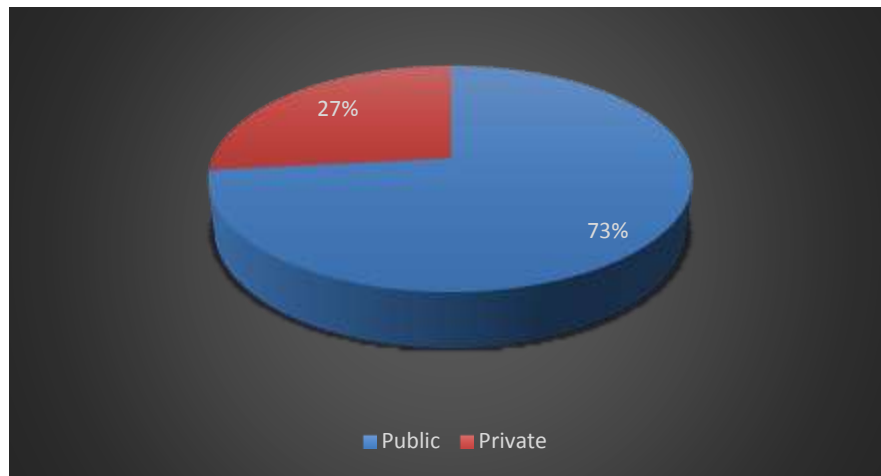


Figure 4.3 : Whether School which a Student is Enrolled in is Public or Private

#### 4.2.2.4 School Midterm Break

The question was meant to seek whether the school where the students are enrolled to had mid-term break. All schools both private and public had midterm breaks.

#### 4.2.2.5 Parent Student Interaction

The question was meant to seek how many times the parent/guardian comes into contact with the student in a term. 69% of the parents come in two contact with the student twice in a single term. 6% of the respondents gave the answer of “a few times” which is not very clear. Figure 4.4 shows the responses to the number of times gets to see a student in a period of one term represented on a pie chat by way of percentages.

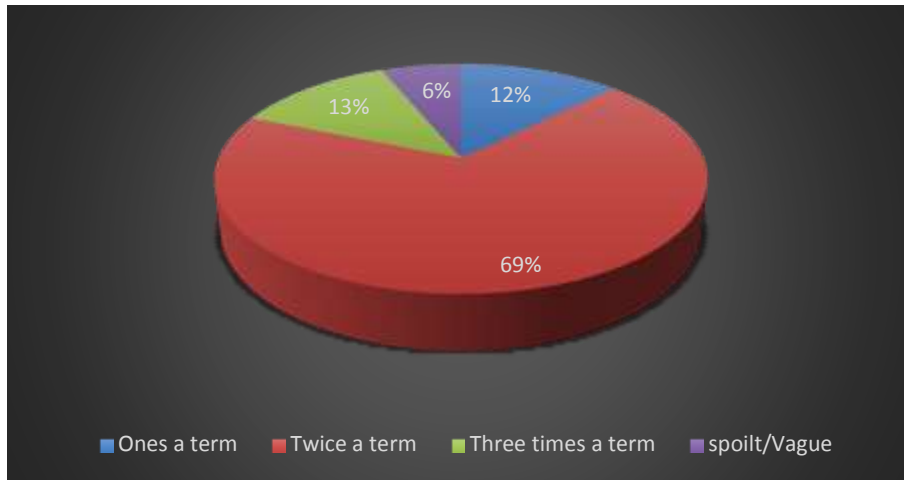


Figure 4.4 : Number of Times a Parent Gets to See the Child in a Term

#### 4.2.2.6 Student Allergies

The question was meant to seek what percentage of the boarding school students had allergic reactions to some food items. 31% percent of the student in boarding schools are allergic to milk protein foodstuff like meat, eggs, milk among other foodstuff. Figure 4.5 shows the responses to whether a child/children is allergic to some food items represented on a pie chart by way of percentages.

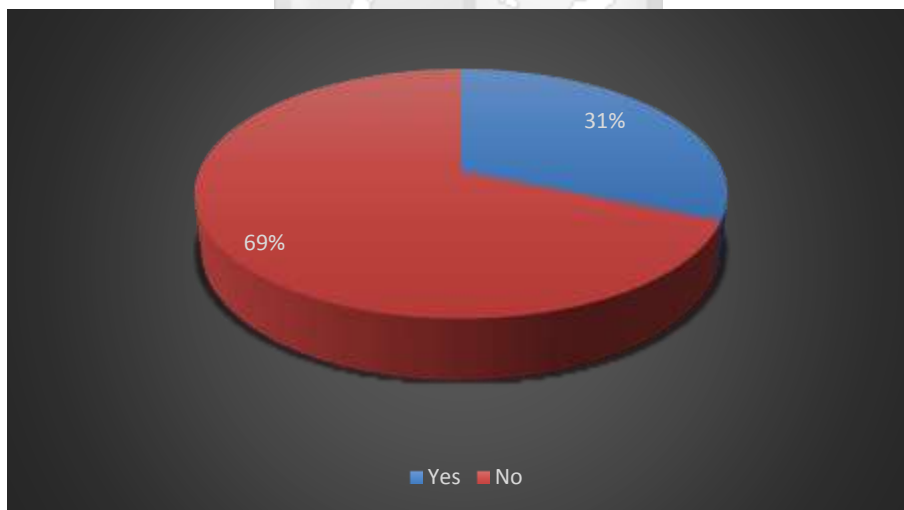


Figure 4.5 : Whether the Student is Allergic to Some Food Items or Not

#### 4.2.2.7 School Home Leave

The question was meant to seek on what percentage of the boarding schools allow home leave for students. 19% do not allow home leave for their students completely while 31% of the schools allow home leave only with a very serious and unavoidable reason. Figure 4.6 depicts the responses to whether home leave is allowed in the school that the child/children are enrolled in represented on a pie chart by way of percentages.

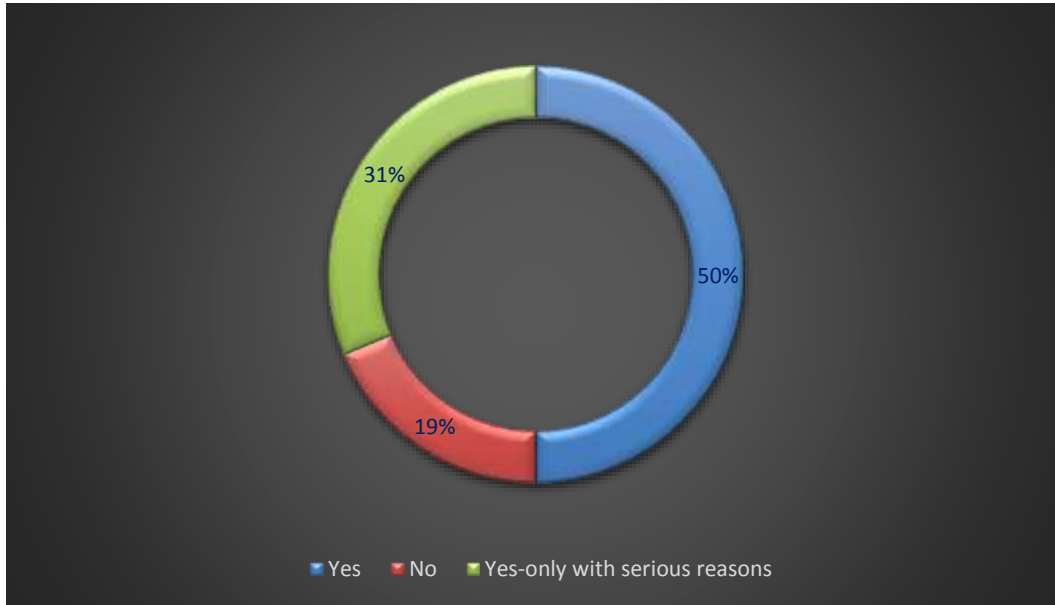


Figure 4.6 : Whether Home Leave is Allowed in School

#### 4.2.2.8 Frustrations Registered Delivering Commodity to Student in School

The question was meant to get an indication on whether a parent have ever experienced frustration in delivering a commodity a student in school or not. 56% of parents have indeed experienced frustration in getting a commodity to their children in school. Figure 4.7 depicts the responses to the question of whether a parent has ever been frustrated in getting a commodity to a student in school due to tight schedule or distance issues represented on a pie chart by way of percentages.

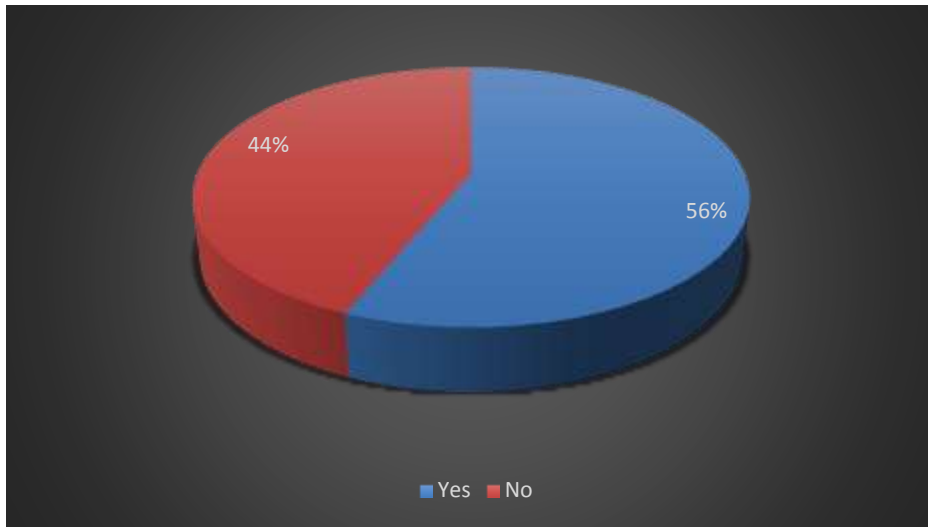


Figure 4.7 : Whether a Parent has Ever Registered Frustration in Getting a Personal Item or Commodity to Student in School

#### 4.2.2.9 The Need for Commodity Delivery System

The question was meant to seek the parent’s opinion whether they think commodity delivery system would be helpful in reducing the frustration of delivery commodity to their children in school. 94% of the parents thought this would be helpful. Figure 4.8 shows the responses to the question of whether the parents think they need the system in the first place represented on a pie chat by way of percentages.

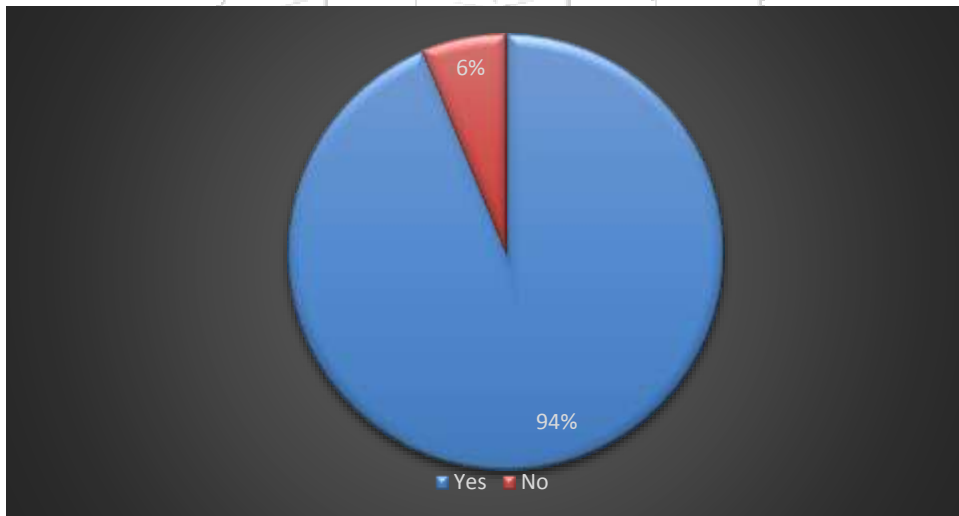


Figure 4.8 : Need of Commodity Delivery System by the Parents

#### 4.2.2.10 Making Payment

The question was meant to seek the parent's opinion on whether they prefer to make payment after delivery of commodity to the student or before delivery. 94% of parents prefer to make the payment after the delivery of commodity. Figure 4.9 depicts the responses to at what point the parent would like to make payment to delivered commodity represented on a pie chart by way of percentages.

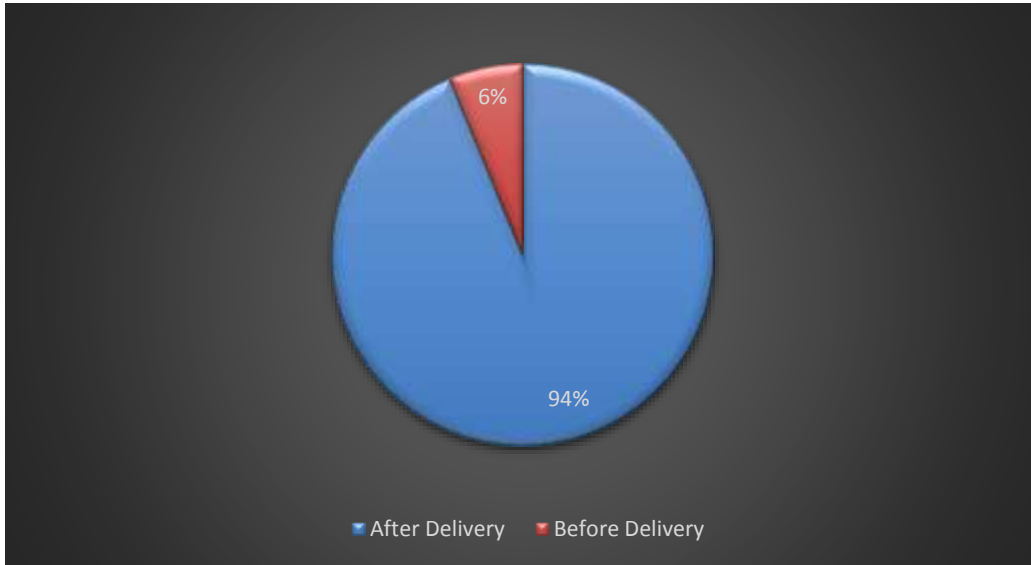


Figure 4.9 : Parents Preference on When to Make the Payment

#### 4.2.2.11 Confirmation of Delivery

The question was meant to seek the parent's opinion on who they would prefer to make confirmation on the commodity delivered. 69% of parents their children to make the confirmation. Figure 4.10 shows the responses to who the parents would prefer to make delivery confirmation represented on a pie chart by way of percentages.

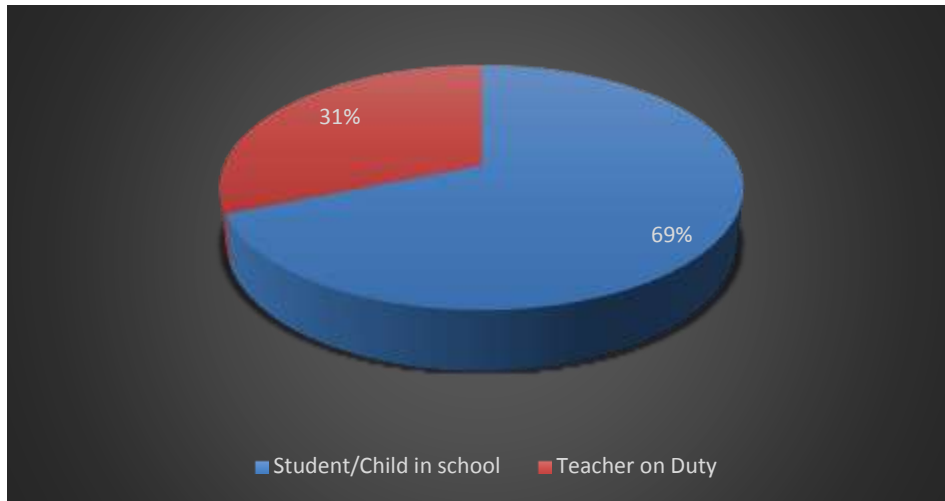


Figure 4.10 : Parents Preference on Whom They Would Like to Make Delivery Confirmation

#### 4.2.3 Students of Boarding Schools

##### 4.2.3.1 Student Gender

The question was meant to seek the gender parity of the students who were interviewed. 65% of the students were male while 35% of the student were female. Figure 4.11 shows the responses to the gender of the student taking part in study represented on a pie chat by way of percentages.

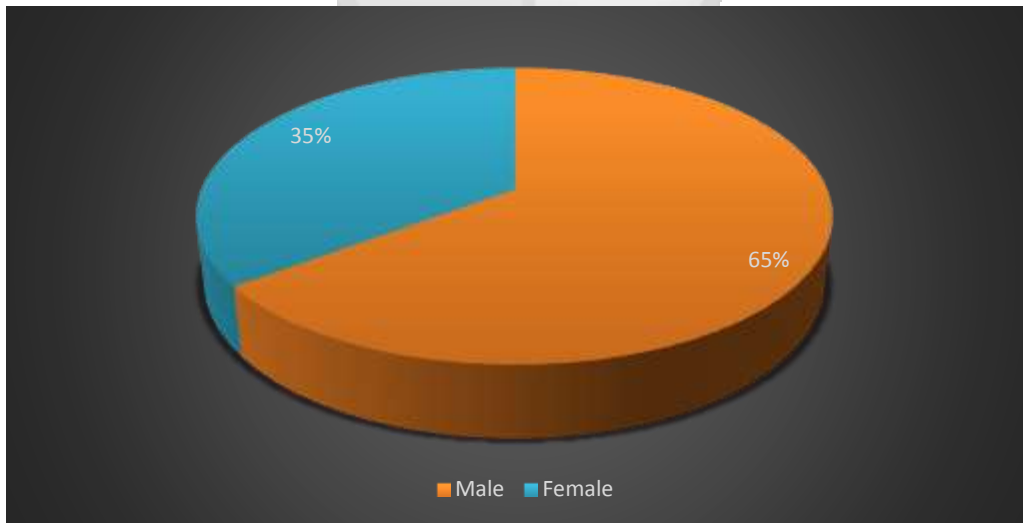


Figure 4.11 : Gender of the Students Taking Part in the Study

### 4.2.3.2 Student Form/Class

The question was meant to seek forms/classes of students who were interviewed. Students from all forms/classes were interviewed with most; 41% coming from Form 3. Figure 4.12 shows the responses to the form of the student taking part in study represented on a pie chat by way of percentages.

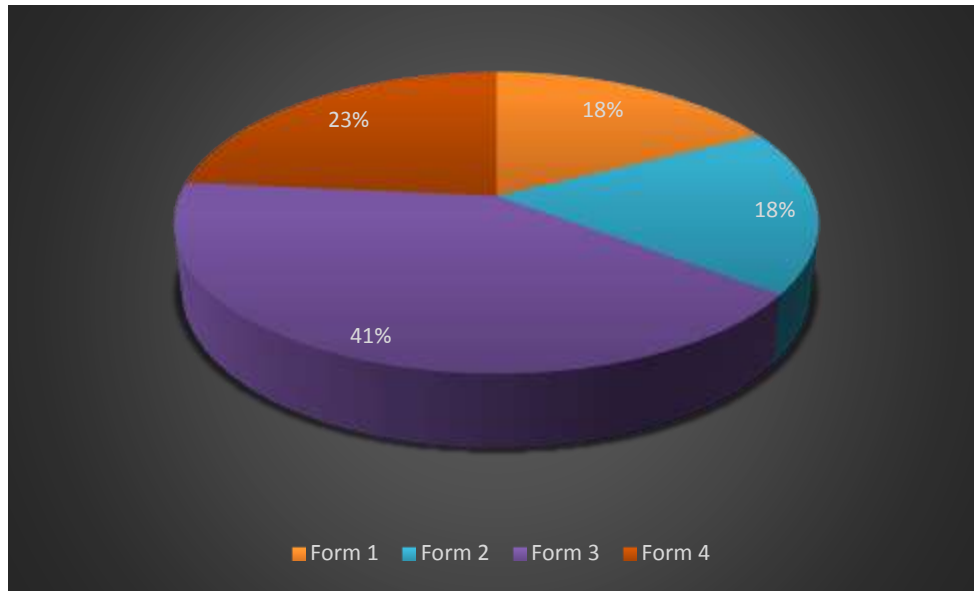


Figure 4.12 : Classes/Forms of Students Interviewed

### 4.2.3.3 Public or Private School

The question was meant to seek on which schools the interviewed students were enrolled in; public or private. 82% of the interviewed students were enrolled in public schools. Figure 4.13 shows the responses to the type of school represented on a pie chat by way of percentages.

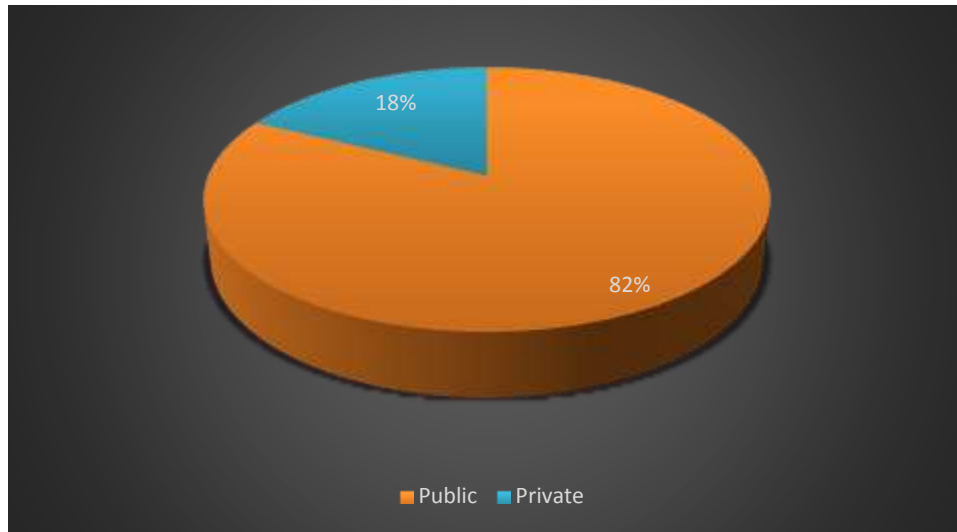


Figure 4.13 : Type of School the Student is Enrolled in

#### 4.2.3.4 School Midterm Break

The question was meant to seek whether the school where the students are enrolled to had mid-term break. All schools both private and public had midterm breaks.

#### 4.2.3.5 Parent Student Interaction

The question was meant to seek how many times the student comes into contact with the parent in a term. 53% of the student see their parents twice a term. 6% of the answers were vague i.e. very few times. Figure 4.14 depicts the responses to the number times a student gets to see the parent in a period of one term represented on a pie chart by way of percentages.

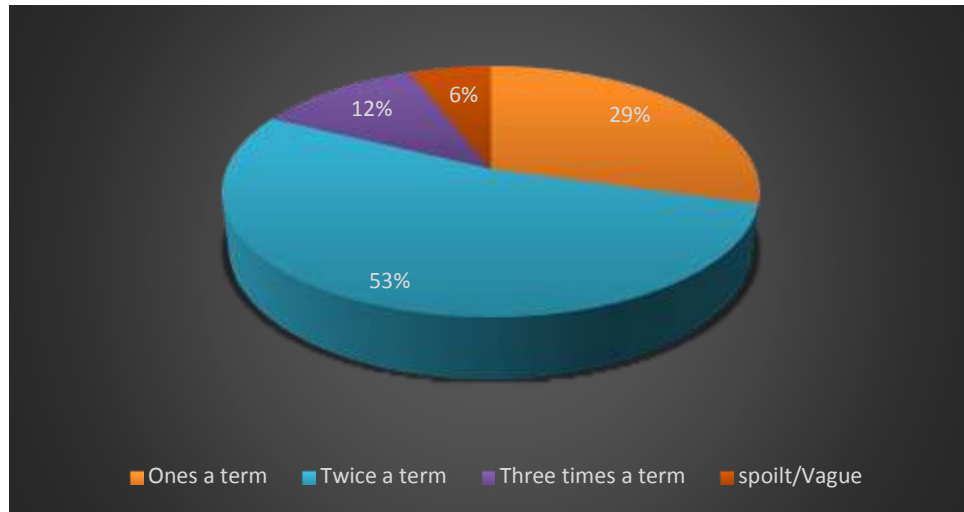


Figure 4.14 : Number of Times the Parent Gets to See the Child in a Term

#### 4.2.3.6 System Authentication

The question sought student views on the login mechanism to the system. Most student, at a percentage of 76%, preferred Student admission number and password to login to the system. Figure 4.15 shows the student responses on what mechanism they prefer to use to login to the system represented on a pie chart by way of percentages.

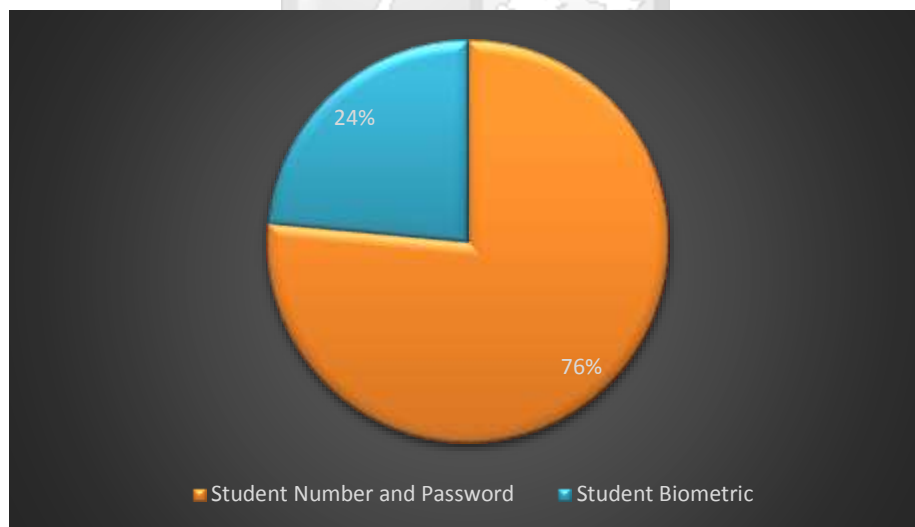


Figure 4.15 : Mechanism for Student Login to the System

#### 4.2.3.7 Regulation on Edible Products

The question was meant to seek if there are rules regarding edible foodstuff that students are allowed with in school. 94% of school have rules on foodstuff that student can bring into the school. The rules ranged from banning of single foodstuff products such as Chapati or Juice to some schools banning all foodstuff. Figure 4.16 depicts the student responses on whether there are school rules in regards to edible products accepted in school represented on a pie chat by way of percentages.

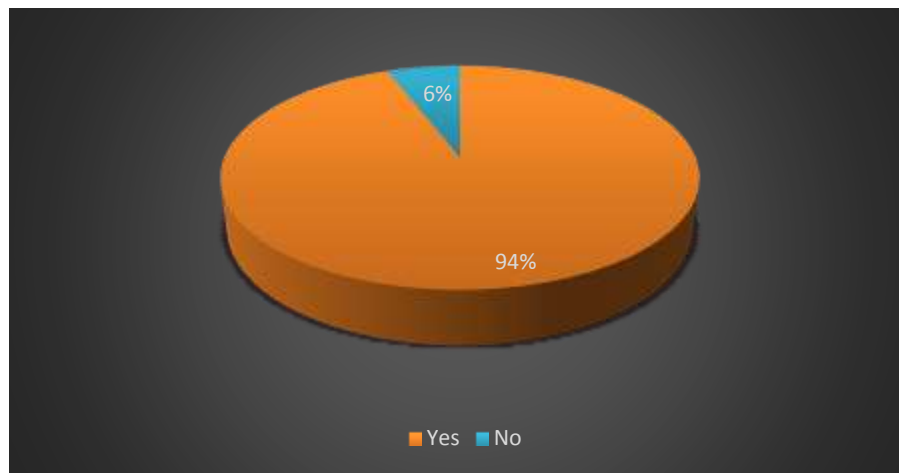


Figure 4.16 : Rules on Edible Products that are Allowed in School

#### 4.2.3.8 School Home Leave

The question was meant to seek if the schools that the students interviewed were enrolled in, had home leave. 59% of the schools had home leave while 41% of the schools did not allow home leave. Figure 4.17 shows the responses to the question of whether home leave is allowed in the student schools represented on a pie chat by way of percentages.

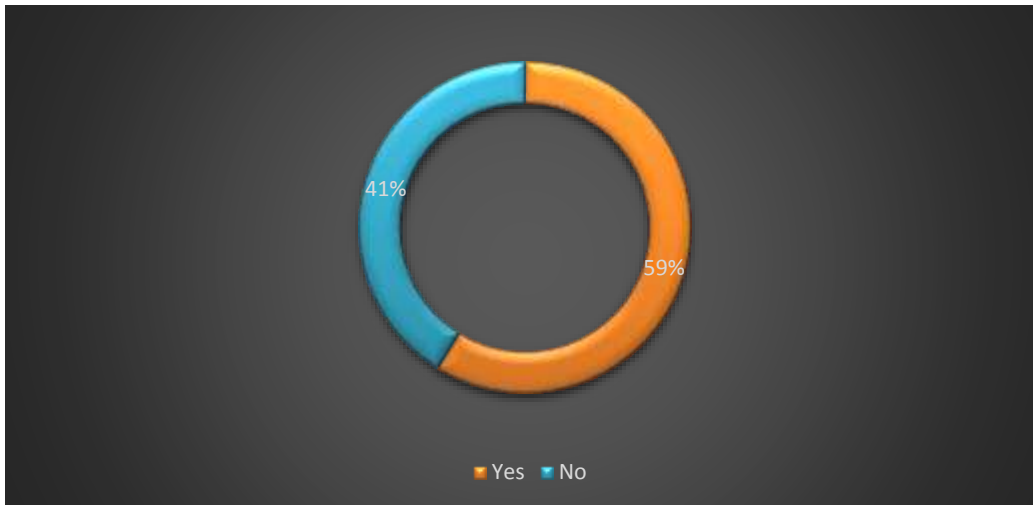


Figure 4.17 : Whether Home Leave is Allowed in School

#### 4.2.3.9 Frustration Due to Need of Personal Effects.

The question was meant to get an indication on whether a student have ever experienced frustration in getting a commodity or pocket money delivered to them by their parents in school or not. 41% of the students have been frustrated before while 59% have not. Figure 4.18 shows the student responses to the question of whether a student has ever been stuck because a parent could deliver a personal effect to them in time represented on a pie chat by way of percentages.

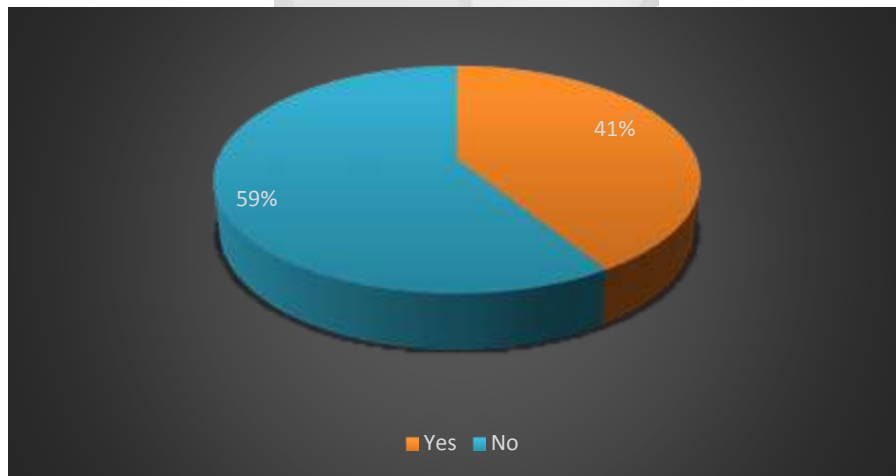


Figure 4.18 : If a Student has Ever Been Frustrated in Commodity/Personal Item Getting Delivered to them in School.

#### 4.2.3.10 Whether the Students thinks they Need Commodity Delivery System to Help their Parents deliver Commodity to them.

The question was meant to seek the student's opinion on whether they think commodity delivery system would be helpful in reducing the frustration of delivery commodity to them in school. All students answered yes to the question confirming the need of the system.

#### 4.2.3.11 Number of Access Times a Week

The question was meant to seek the student's views on how many times they would want to access the system in case it is implemented. 47% of the student were for once a week with the days preferred ranging between Friday, Saturday or Sunday. Figure 4.19 shows the student responses to the question on the number of times a week the students would need to access the system represented on a pie chat by way of percentages.

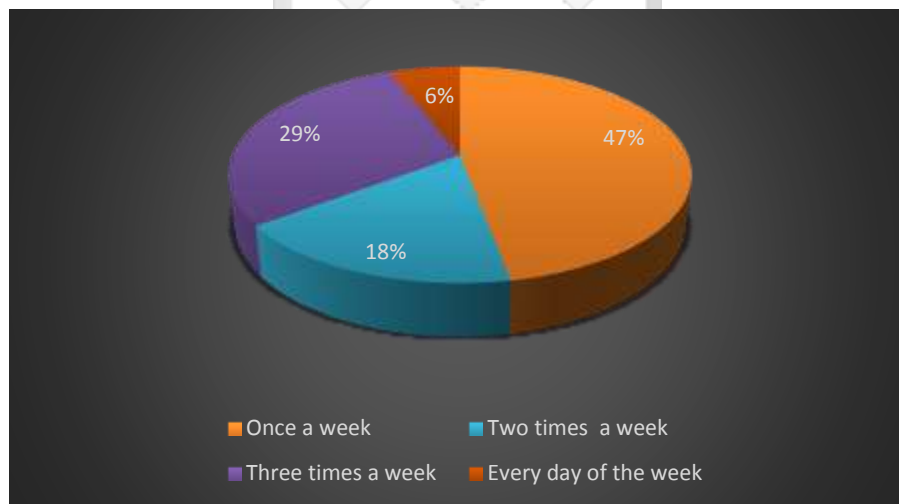


Figure 4.19 : Number Time(s) the Student would Like to Access the Commodity Delivery System

#### 4.2.3.12 Access Day Preference

The question was meant to seek the student's views on which days of the week they would prefer to access the system. The analysis focused on the majority of the students who want to access the system once a week. Of the 47% of students who wants to access the system once a week, 43% of them prefer Saturday to access the system. Figure 4.20 shows the student responses to on which day the student would prefer to access the system represented on a pie chat by way of percentages.

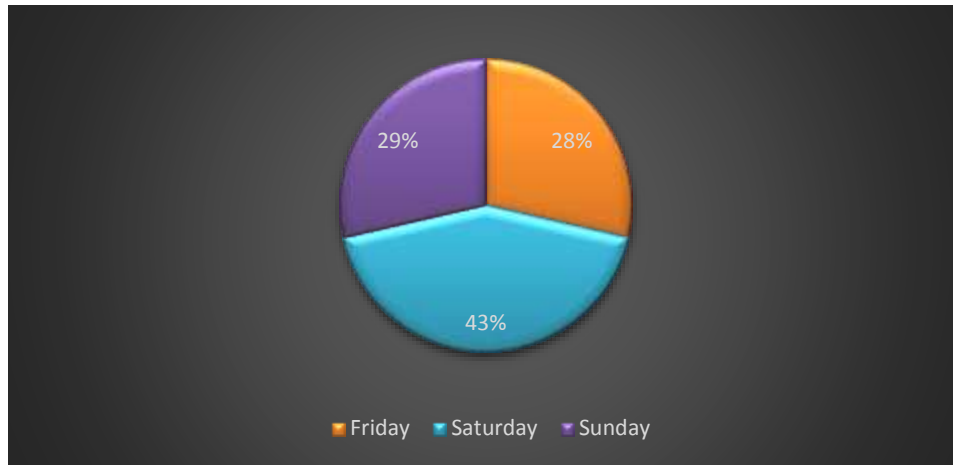


Figure 4.20 : Day Preferred by the Students to Access the System

#### 4.2.3.13 Commodity Delivery Collection

The question sought student views on who should collect the commodity that has been ordered by the parent. 47% of the student would like to collect the commodity by themselves. A very peculiar number (12% of the students interviewed) of students chose “others” and other names such as Class Captains or Boarding Master as the individuals they would like to collect the commodity. Figure 4.21 depicts the responses to the question on the students’ preference on who they would prefer to collect the delivered commodity represented on a pie chat by way of percentages.

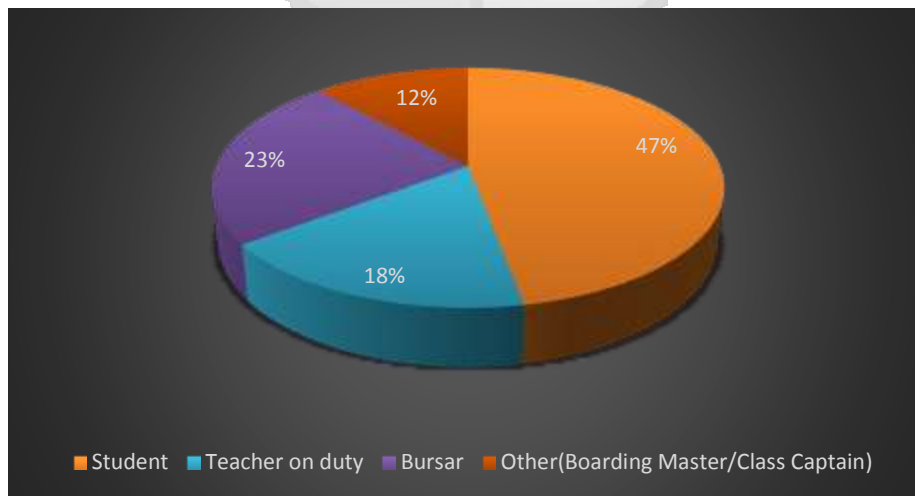


Figure 4.21 : Students’ Preference on Collection of Commodity

#### 4.2.3.14 Student Delivery Confirmation Point

The question sought student views on when they would like to make confirmation to their parents on safe delivery of the personal effects so that the parent can conclude the transaction. All students preferred that the notification be sent to the parent only after they have received the delivered commodity.

#### 4.2.4 Boarding Schools Administrators

##### 4.2.4.1 Public or Private School

The question was meant to seek whether the school taking part in the study was public or private. 76% of the schools were public schools. Figure 4.22 shows the administrators' responses to the question of whether the school they represent is public or private represented on a pie chart by way of percentages.

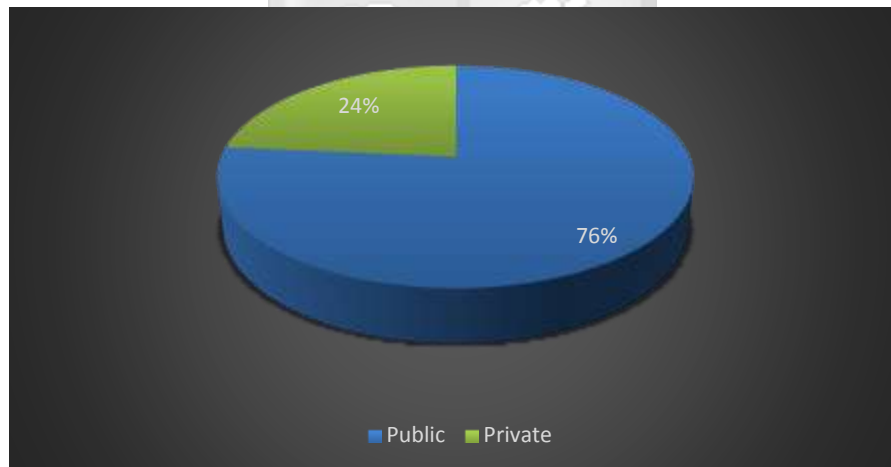


Figure 4.22 : Type of School Taking Part in Survey

##### 4.2.4.2 School Midterm Break

The question was meant to seek whether the schools taking part in study had mid-term break. All schools both private and public had midterm breaks.

##### 4.2.4.3 Parent Participation Events

The question sought to find out the probability of parents coming to school and hence in some cases meeting their children. Most schools - 59% of schools have two events per term that need

the parents to come to school. Figure 4.23 depicts the administrator responses to the question on the number of events that involves parent coming to school represented on a pie chat by way of percentages.

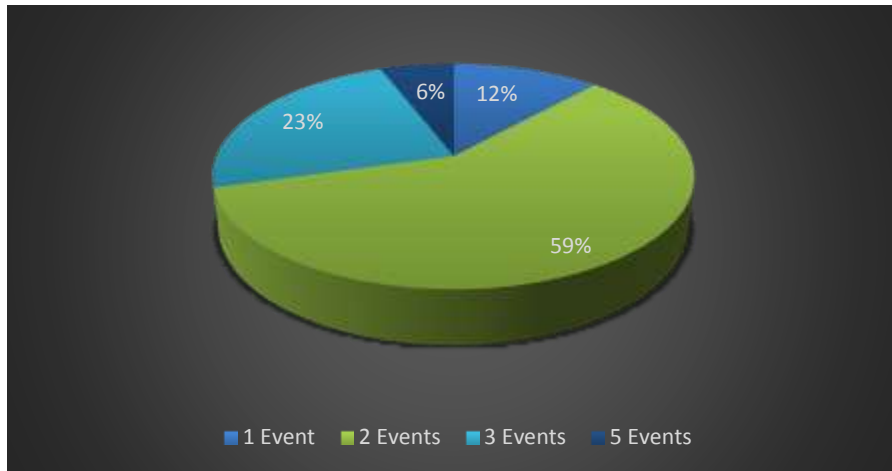


Figure 4.23 : Events Per Term that Parents can Attend

#### 4.2.4.4 Rules on Edible Products

The question was meant to seek if there are rules regarding edible foodstuff that students are allowed with in school. 90% of school have rules on foodstuff that student can bring into the school. The rules varied from school to school. Figure 4.24 depicts the administrator responses to the question on whether there are rules on edible products that are allowed in School represented on a pie chat by way of percentages.

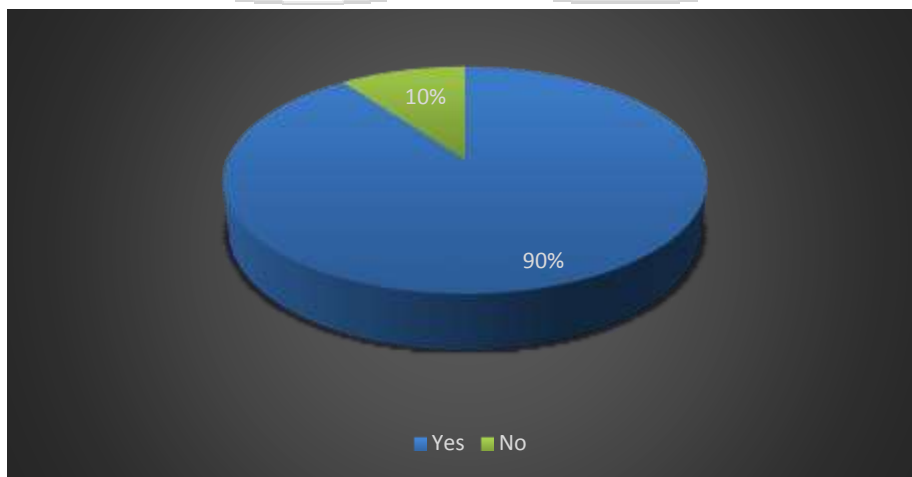


Figure 4.24 : Rules on Edible Products

#### 4.2.4.5 School Home Leave

The question was meant to seek if the schools taking part in study allowed home leave. 60% of the schools allowed home leaves. Figure 4.25 depicts the administrator responses to the question on whether home leave is allowed in the school represented on a pie chat by way of percentages.

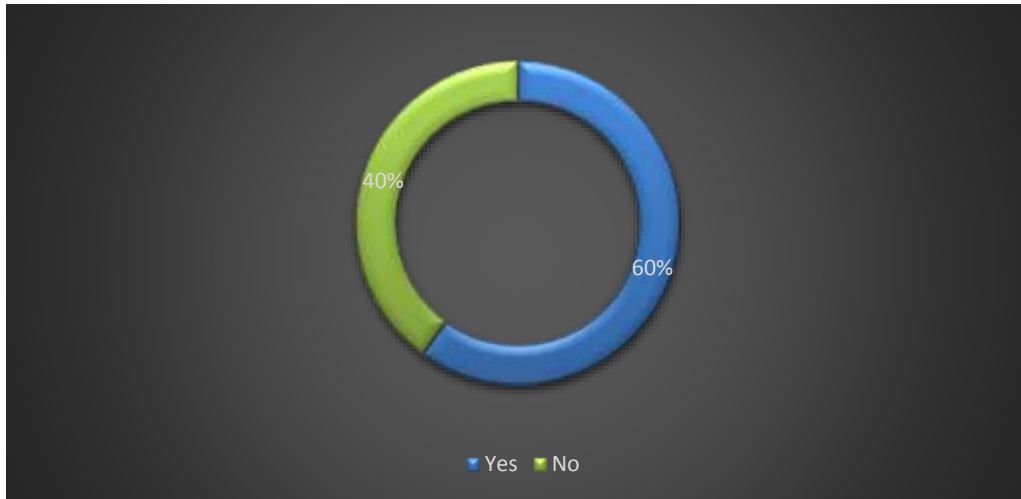


Figure 4.25 : Option of Home Leave

#### 4.2.4.6 Interaction with the Outside World

The question was meant to seek if the schools taking part in study allowed students to have interaction with the outside world. 53% Percent of the schools do not allow interaction with the outside world. Figure 4.26 depicts the administrator responses to the question on whether the schools allows interaction with the outside world represented on a pie chat by way of percentages.

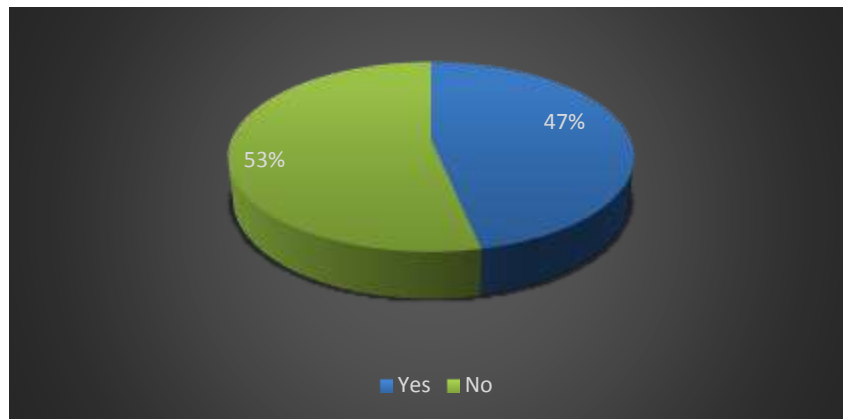


Figure 4.26 : Schools Allowance of Interaction with Outside World

#### 4.2.4.7 Vetting of Delivery Persons.

The question was meant to seek if the schools taking part in study would allow vetted individuals to do deliver to the schools. Views were split in the middle with half of the schools indicating that they would allow this. Figure 4.27 depicts the administrator responses to the question on whether the schools would allow vetted individuals from supermarket chains to deliver commodity to students represented on a pie chat by way of percentages.

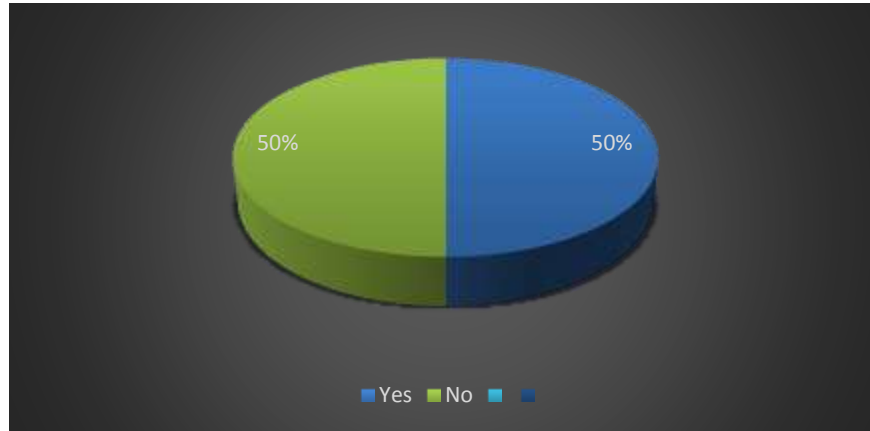


Figure 4.27 : Openness of Schools to Allow Vetted Individual to do Delivery

#### 4.2.4.8 To Implement or Not

The question sought the views of the school administrator on the implementation of commodity delivery system for boarding school. 65% of the comments were positive. Some of the positive comments touched on saving of time to more reserved comments of the system only delivery personal effect and not food products. The negative comments ranged from reservation on the system's possibility of bringing social stratification in schools to outright rejection of the system with the view that contraband ad illegal products may be smuggled to schools. Figure 4.28 depicts the administrator responses to their thoughts of the school administrator on implementing commodity delivery system for students in school represented on a pie chat by way of percentages.

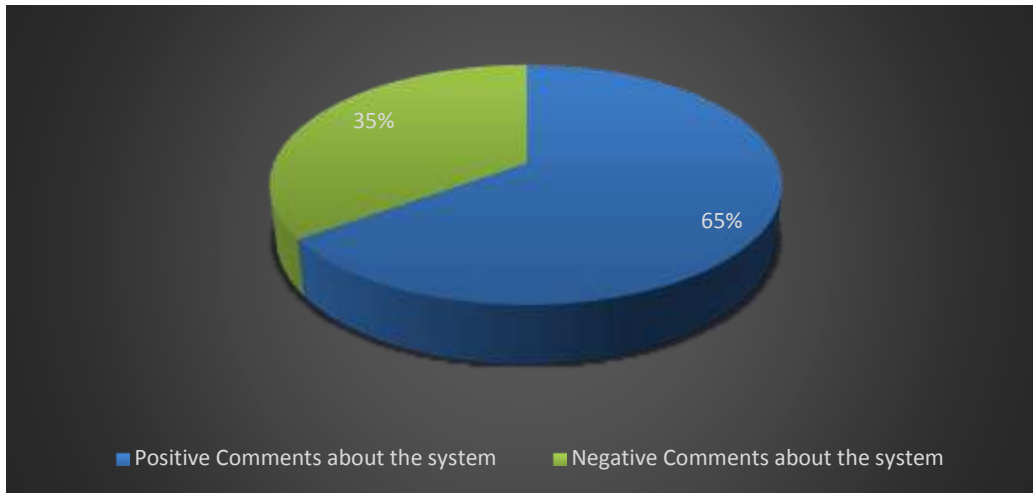


Figure 4.28 : School Administrators' Comments about the System

#### 4.2.4.9 Access of the System

All schools want the teachers to interact with the system. One school however, was not sure who to allow access of the system.

#### 4.2.4.10 Days for System Access

Access All schools would allow students to access the system only once a week. The most preferred day to access the system was Saturday, with all the schools preferring Saturday as a day they would allow students to access the system.

#### 4.2.4.11 Web Application or Mobile Application

All schools would like to access the system as a web based system on computers or if you like as a website.

#### 4.2.4.12 Commodity Collection and Vetting

All schools would like the teacher on duty to collect the commodity from the delivery personnel and inspect and vet the commodity before passing it to the student.

### 4.2.5 Summary of Data Analysis

The system must allow a parent to be able to register more than one child in the system as a good percentage of parents have more than one child in a boarding school at secondary level as shown

on section 4.2.2.1. The system must allow the parent to feed information for each of the children including relevant school information such as Index number, class of the student and the dormitory of the student for ease of identification by the teacher on duty. The system should also allow the parent to enter details that are more specific to the students such as their food allergies. On confirmation of Order by the parent, the exact amount of the cost of commodity and delivery estimation is subtracted from the parents MPESA account and held by the system TILL number. The money is released to the supplier only after confirmation of delivery via the system as illustrated by the response of the parents in section 4.2.2.

The students must be able to login to the system using Student Index Number and Password; choose commodity that they would like sent to them by the parent to school, and put in a request for these products. They must be able to track the status of the request, by logging into their profiles and viewing their requests. They must be able to see if a parent approved the request or not. If approved they must be able to see which supermarket has accepted the order and how long before the delivery is made to them. The student should be able to make confirmation of successful delivery after receiving the commodity. This is illustrated by the response from the students in section 4.2.3 of this work.

School administrator must be able to login to the system using email address and password; and be able to see all students who are registered in the system, all the requests they have put through and the parents of these students as listed in the system. The school administrators must be able to add products that are not allowed into school unto a list of contra banned products for this particular school. This means that these products cannot be able to be ordered by students in this school. The school administrator should be able to access all the contacts of the parents registered in this system and be able to send them personal notification/emails as articulated from the response in section 4.2.4. The school administrator should be able recommend banning of a certain delivery outlet, not to deliver their school. The systems main administrator should be able to consider the reasons behind this recommendation and see if banning is necessary.

#### **4.2.6 Data Analysis Discussions**

From the data analysis, the project was able to get guidance on the requirement of the system. One of the key system requirement was the type of application to develop, whether mobile application

only or web and mobile application. Most of the school preferred to access the system through a web based platform. Most parents however, preferred the mobile interface to access the system.

The parents preferred to make payment after the delivery was made to the student in school. This meant that, the project had to find a way of ensuring that the payment is only made after delivery and without failure of payment to supplier after going to the trouble of making delivery to school. The project hence introduces a merchant account that receives funds commitment from the parent when they approve delivery. These funds are only released to the supplier account after delivery notification is received.

Most schools have products that are not allowed inside the schools. This calls for the system enabling the schools to be able to ban the product not allowed and hence remove the product from the catalogue list for students in this particular school but not for all other schools. The parent is also able to flag a product that the child is allergic to so that the product does not show on the catalogue for the student to order.

Most schools preferred allowing students to access the system only ones a week. The day preferred varied but Saturday stood out as one of the most preferred. The system therefore should have a setting on the school administrator's dashboard to set the day they allow the students to access the system. This way, the system will be able to control the dashboard of the students by being inactive in other days and only be active on the days that are setup by the school administrator.

### **4.3. Requirements Analysis**

The system should capture data from various distributors on stock level of various commodities that they hold. It should also capture data on the location of the schools and other important and relevant attributes of the schools. The system should capture information about the parents including confidential information such as emails and mobile numbers. The parents are also able to feed into the system, their children's information such as a student Index Number, and other relevant and important information such as allergies to certain consumable products.

The system should be location based; by locating the school, it should be able to provide an array of option in regard to the commodity suppliers and how far the suppliers are located from the school and hence calculate the cost of delivery to the school for the parent.

#### **4.3.1. Functional Requirements**

##### **Type of Application (Web Based Application vs Mobile Based Application)**

Schools preferred the student and the school administrator to access the system via web application. This meant that the system has to have a web-based interface for users. Parents on the other hand preferred both mobile and web based interface. This called for mobile interface for the parents and other users who prefer mobile interface

##### **Payment of Order**

The parents want to make payment only after receiving notification of commodity delivery. The supplier will not act if they does not receive any form of commitment from the parent. The project therefore introduced a merchant to hold the funds that the parent commits when they approve a delivery. These funds are only released to the supplier after delivery have been made to the school and the parent and the merchant receives a notification of successful delivery.

##### **Smart System**

When placing an order, the system should not give as an option of any product that was flagged by the parent as a product that the child is allergic to. The child should not be able to order a product that they are allergic to or any other that the parent does not want them to have. All products that has been added to the contraband list by the school administrator should be unavailable for the student to choose from.

Once a parent confirms an order, the system should be able to locate a commodity supplier nearest to the school to cut on delivery cost and facilitate faster delivery of the commodity. The system should be able to calculate the distance to the school from the commodity supplier and give a fair cost for delivery of the commodity.

Commodity stocks levels should be in real-time: when a parent orders five blankets and the supplier has only five in the stock, another parent trying to order blanket from this supplier should get a notice that the supplier has run out of stock and prompt the parent to search for other nearby suppliers.

### **Students Login**

Most of the schools preferred that students should be able to login to the system only once in a week. The most preferred day was Saturday about this can vary. The system should therefore has a setting on what day of the week in the school in question that students are allowed to login into the system. This will be implemented by ensuring that the student dashboard is only active on the day and that is setup in the school administrator profile of the school to be the day that students are allowed to access the platform

### **Anonymity**

As a result of discussion with the school administrators, there were fears of security of the students should their identity be readily available to the suppliers and hence the delivery persons. This was a major concern for national schools who have student belonging to politician. This is necessitated the development of the system to be totally anonymous. The delivery person must not know the name of the student they are delivering the products to. They should just have a request ID that matches the request ID of the request raised by the student. This is to ensure protection of students especially, students from political families who can be harmed if their identity is known.

Though the whole process would work best and hence encourage a good rapport between the deliveries person with the school administrators, it does not encourage rapport of the delivery persons with the students. This ensures the avoidance of the privilege of contact with the outside world getting abused.

## **4.3.2. Non-functional Requirements**

### **Intuitive**

The system use should be intuitive enough to allow parents and children who have never been to computer class can be able to use the system.

The students should be able to select the product that they would like to request without getting lost in the system. The system should be smart enough to remember the products that the student has been requesting at certain periods of the term and hence give suggestions of these products.

Some of the parents are not technology savvy; the system should be intuitive enough for even a parent who has low interest in technology to be able to enter records of new student, make amendments to a student request and approve a request of student without requiring much help from a third party

### **Durable with fault tolerance**

The system should be fault tolerant given that among its users are students who might be green in technology and plain naughty on one end and the old with little or no training or interest in technology. The system therefore, should anticipate all wrong moves of the users and try to have as many responses to these moves as possible.

Though the system cannot cover all fault lines, the system should be tolerant as possible to avoid frequent system crashes.

## **4.4. System Design**

The project ultimate objective is to develop a mobile application that is running in a handheld device such as mobile phones and tablets. These devices run on varied operating system technologies and though android devices dominates the market(Dar & Parvez, 2014; IDC, 2017), the project cannot side-line other technology users. For this reason, the platform is using API to deliver the system to the various mobile technologies, in case of growth in future. Currently we have the following operating systems for smartphones in the market: Android from Google, iOS from Apple, Palm OS, Symbian OS, and Windows Mobile.

This work tries to accommodate all mobile platforms by developing the mobile application using Ionic framework. Ionic framework uses Apache Cordova project to build and run mobile application as native mobile application.

Figure 4.29 and Table 4.1 Depict the world market share of the various smartphone operating system.

Table 4.1 : Worldwide Smartphone OS Market Share (Share in Unit Shipments) (Adapted from IDC, 2017)

Period	Android	iOS	Windows Phone	Others
2016Q1	83.4%	15.4%	0.8%	0.4%
2016Q2	87.6%	11.7%	0.4%	0.3%
2016Q3	86.8%	12.5%	0.3%	0.4%
2016Q4	81.4%	18.2%	0.2%	0.2%
2017Q1	85.0%	14.7%	0.1%	0.1%

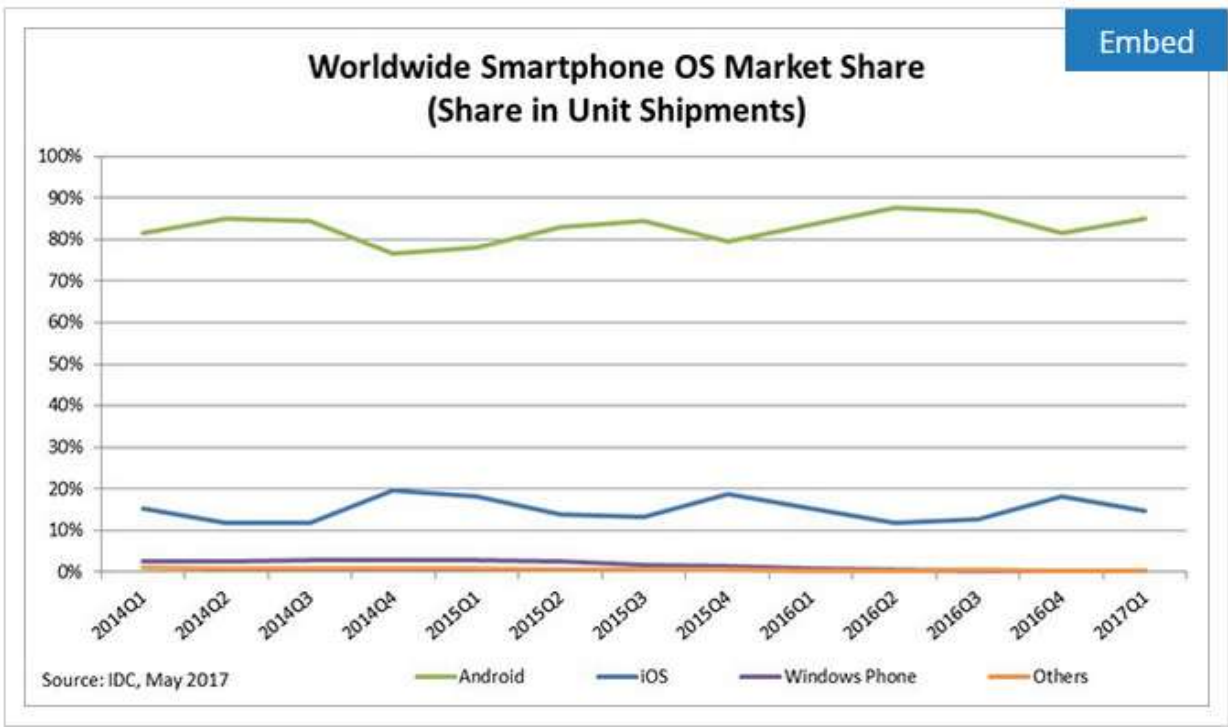


Figure 4.29 : Worldwide Smartphone OS Market Share (Share in Unit Shipments) (Adapted from IDC, 2017)

#### 4.4.1 System Architecture

The whole system (includes the API, database, web) should be hosted on the cloud; Linode Cloud VPS services. Hosting on the cloud provides easy access to on-demand scalable infrastructure, which only incurs a “pay for what you use” cost; kind of utility services. Figure 4.29 shows the system architecture of the platform.

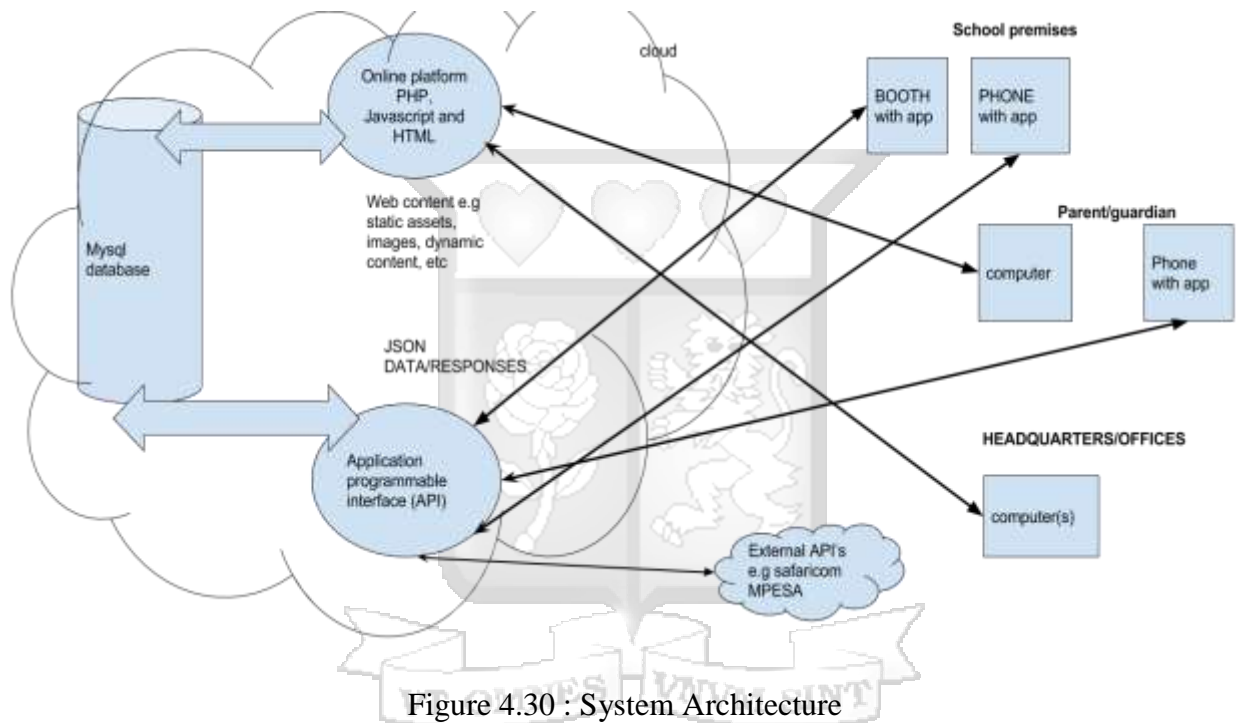


Figure 4.30 : System Architecture

#### 4.4.2 Context Diagram

Figure 4.30 depicts the context diagram of the system. The database and the system itself is hosted on the Linode cloud VPS services. APIs are then be deployed to deliver the system to the various devices depending on the devices in question. The project has employed media query to determine the type of media, the size of the screen of the device for the correct delivery of the services

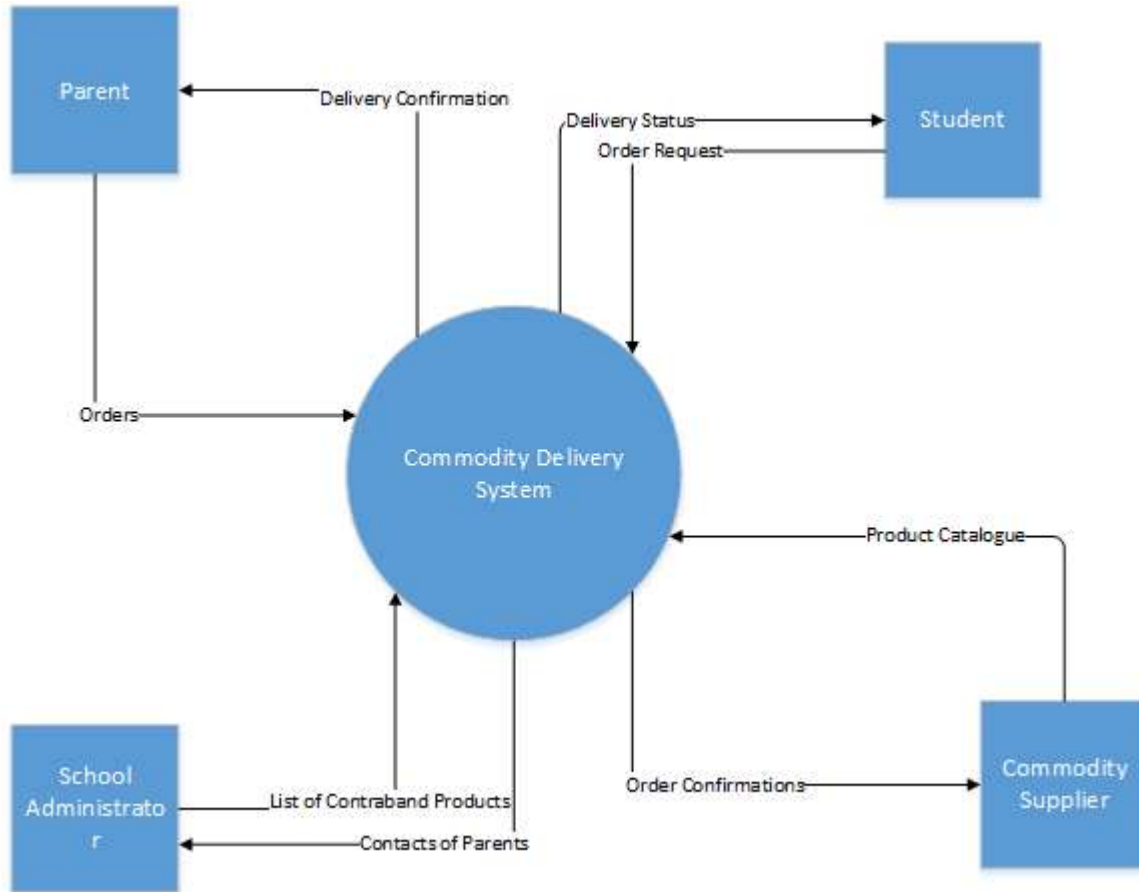


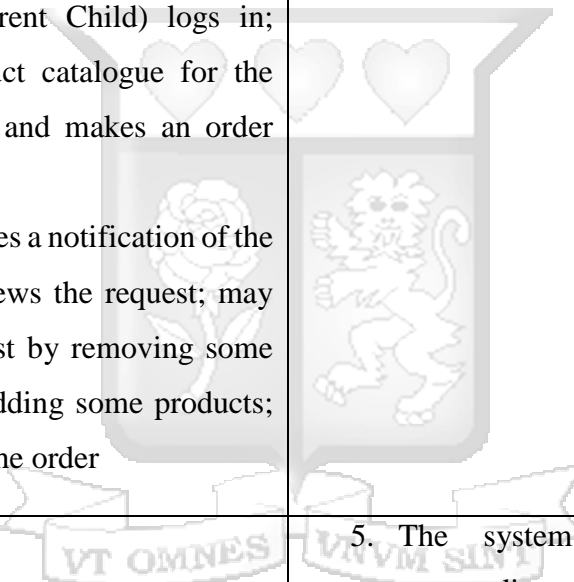
Figure 4.31 : Context Diagram of the System

#### 4.4.3 Use Case Diagram

Figure 4.33 depicts the use case diagram for the system. The use case has the parent, the commodity supplier and the school administrators as the Primary actors; student as the support actor; and Mpesa and Government as the offstage actors. Table 4.2 gives us the use-case main success story.

Table 4.2: Use Case Main Success Story

ACTOR ACTIONS	SYSTEM RESPONSE
1. Use case begins when a parent registers to the system and in the process registering his child/children to the	

<p>system. The app is configured to authenticate on the cell number that it was installed on and the Gmail account of the user. The parent is provided with passwords for the children. username is the parent Cell number</p>	
	<p>2. System save the user data in the database with passwords hushed. Saves the school location of the children.</p>
<p>3. The student (Parent Child) logs in; search the product catalogue for the needed products and makes an order request</p> <p>4. The parent receives a notification of the order request; views the request; may amend the request by removing some products or by adding some products; parent confirms the order</p>	
	<p>5. The system locates the nearest commodity supplier to the school.</p> <p>6. The system calculates the distance to school and gives a total of the cost of products and the delivery cost</p>
<p>7. The commodity suppliers confirms that they have all the products in the order submitted by the parent</p> <p>8. Parent makes the payment via Mpesa</p> <p>9. Products are delivered within the time calculated in the system.</p>	

10. The student receive the products and initiate confirmation of delivery in the system	
	11. Confirmation of delivery is sent to the parent as well as the commodity supplier.



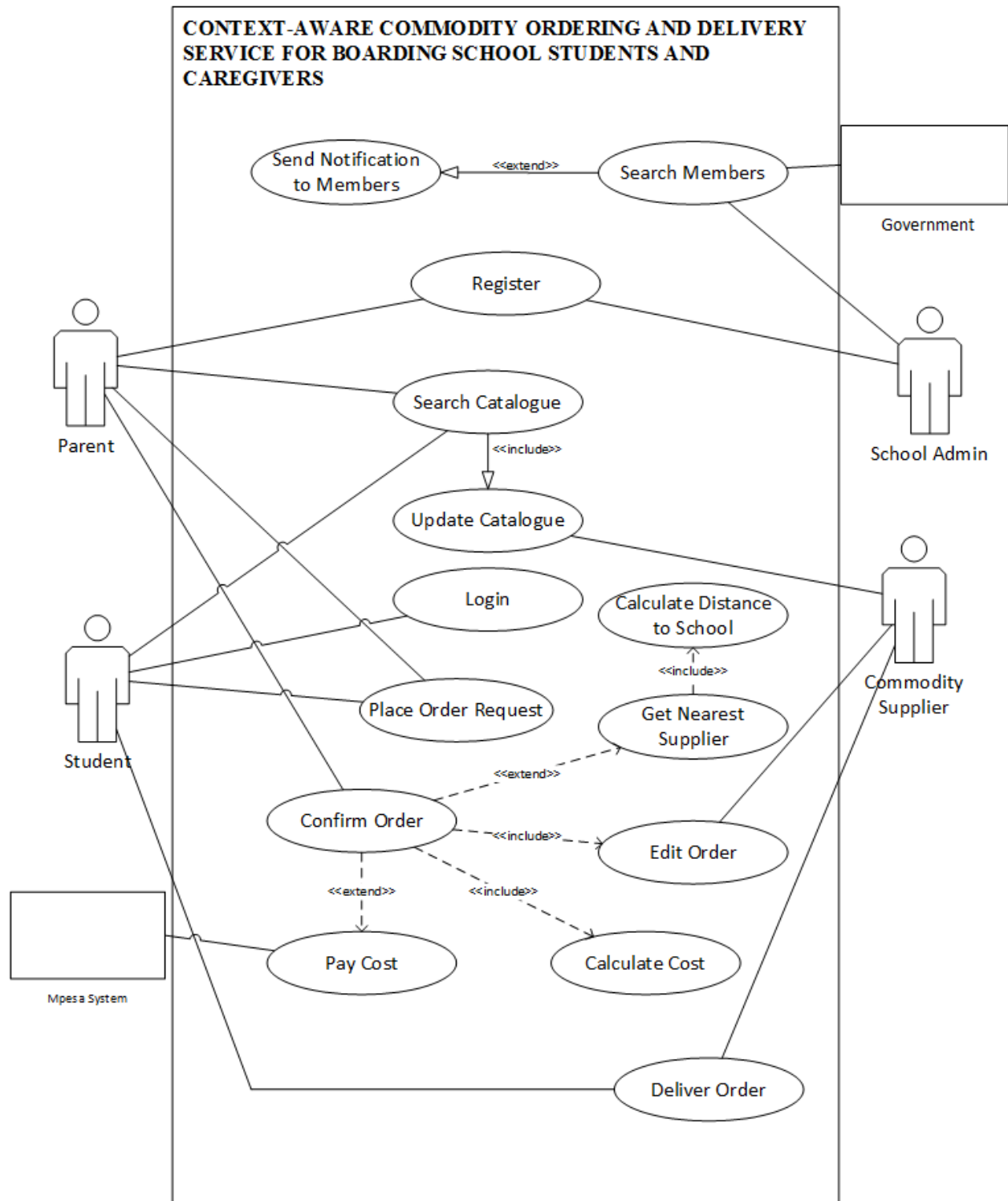


Figure 4.32 : Use Case Diagram

#### 4.4.4 Sequence Diagram

Figure 4.34 shows the various actors and the sequences of various functions that they invoke and respond to. Though the students initiate the request, the parent remain one the primary actor, interacting with the system in various levels.

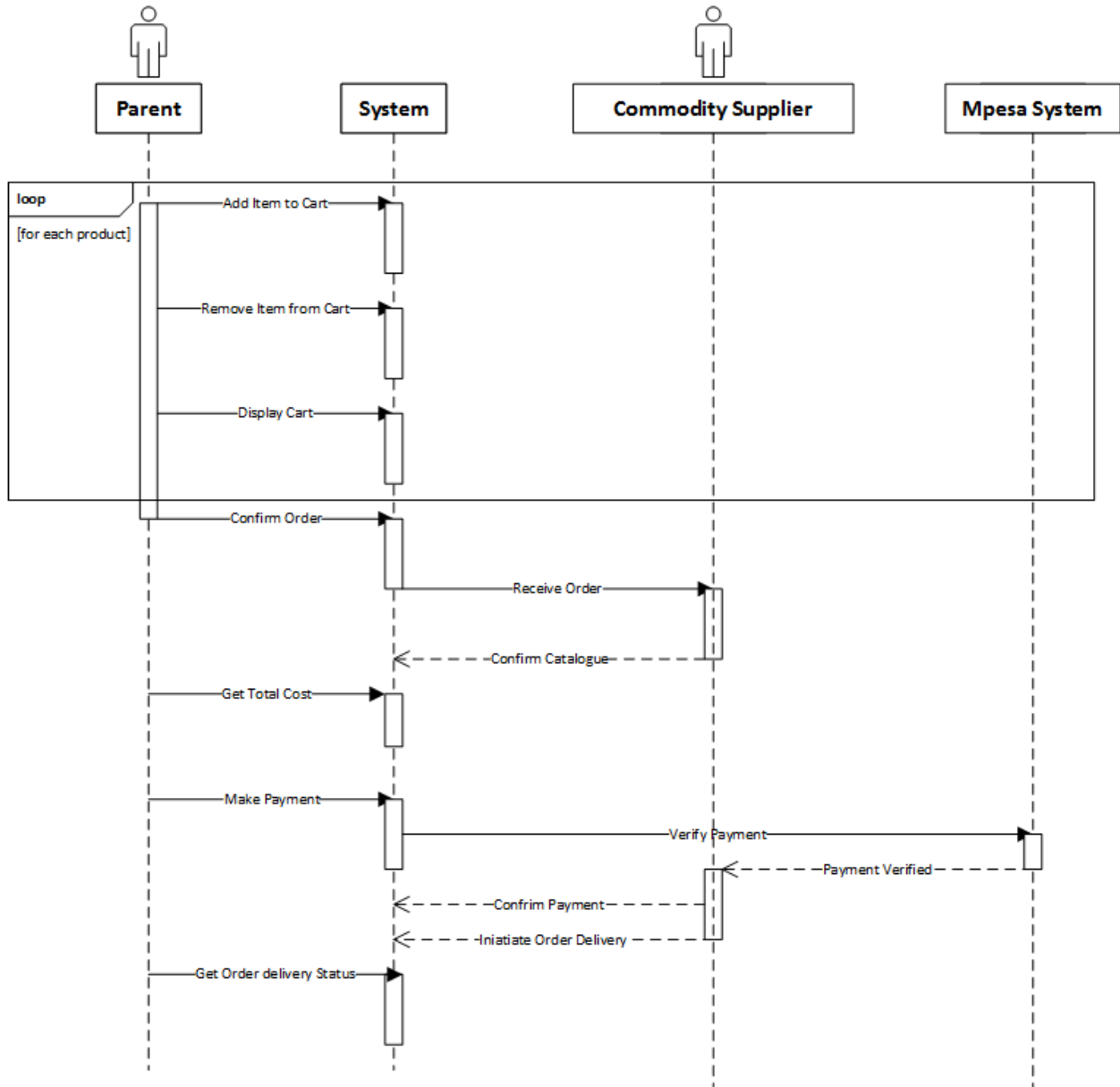


Figure 4.33: Sequence Diagram of the System

#### 4.4.5 Data Flow Diagram

Data-flow diagrams (DFDs) were introduced and popularized for structured analysis and design in the late 1970s (Gane & Sarson, 1979). A Data Flow Diagram (DFD) is traditional visual representation of the information flows within a system. A neat and clear DFD can depict a good amount of the system requirements graphically. A formal way of representing how a business operates. It illustrates the activities that are performed and how data moves among them. Figure 4.34 illustrates the systems data flow diagram.



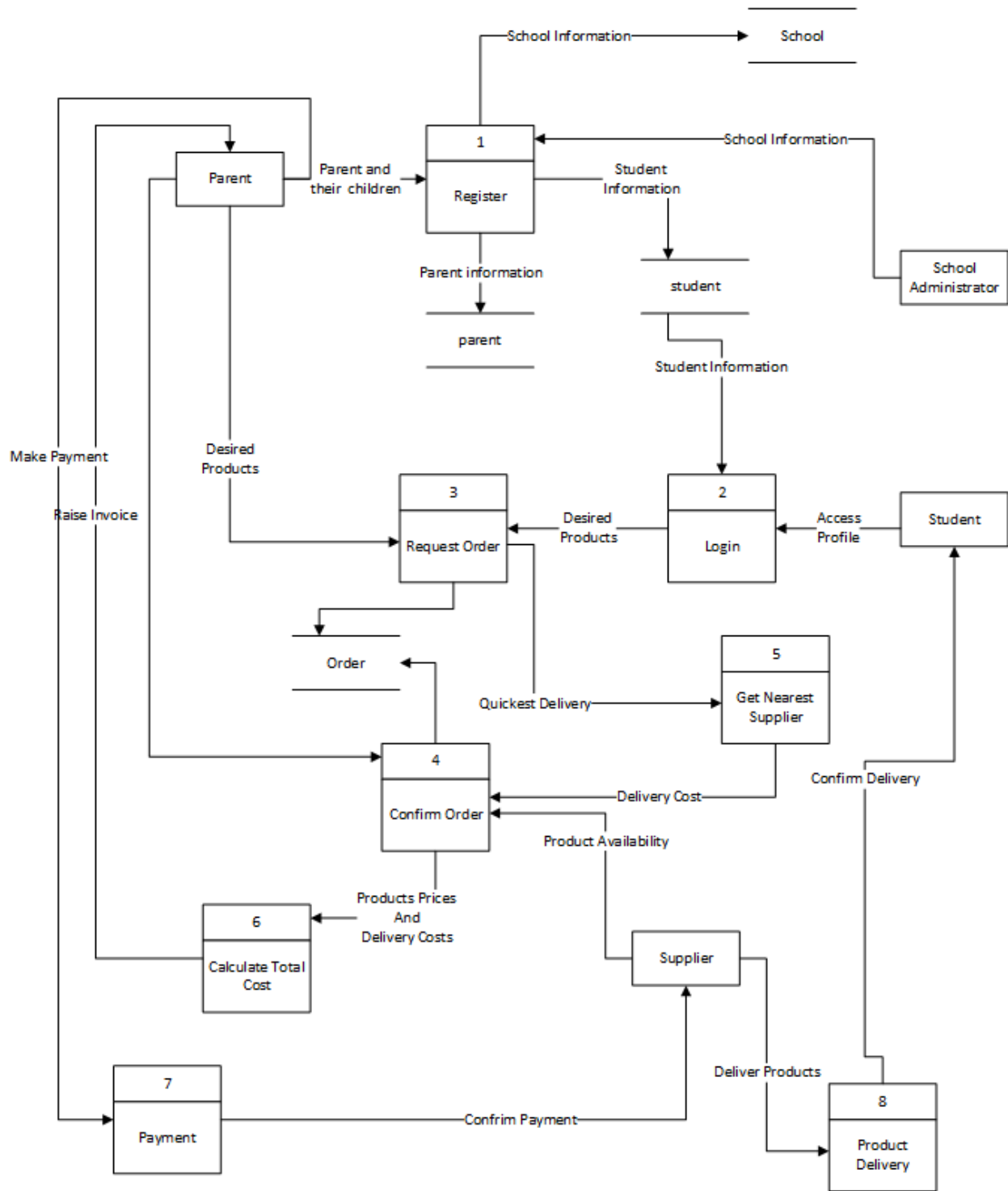


Figure 4.34 : Data Flow Diagram of the System

#### 4.4.6 Entity Relationship Diagram

Designing of Database using the technique of Entity-Relationship (E-R) modelling has become relatively common since the proposal of the technique by Chen in the 1970s (Griffiths, 1989) and continue to be the most common means of documenting the data requirements of information systems (Atkins & Patrick, 2000). Entity-relationship model (or E-R model) is a detailed, logical representation of the data in an organization is expressed in terms of business environment, relationships (or associations) among entities and the attributes (or properties) of entities and their relationships. Figure 4.35 illustrates Entity Relationship Diagram of the Location-based Commodity Ordering and Delivery System: Case of Boarding Schools in Nairobi.



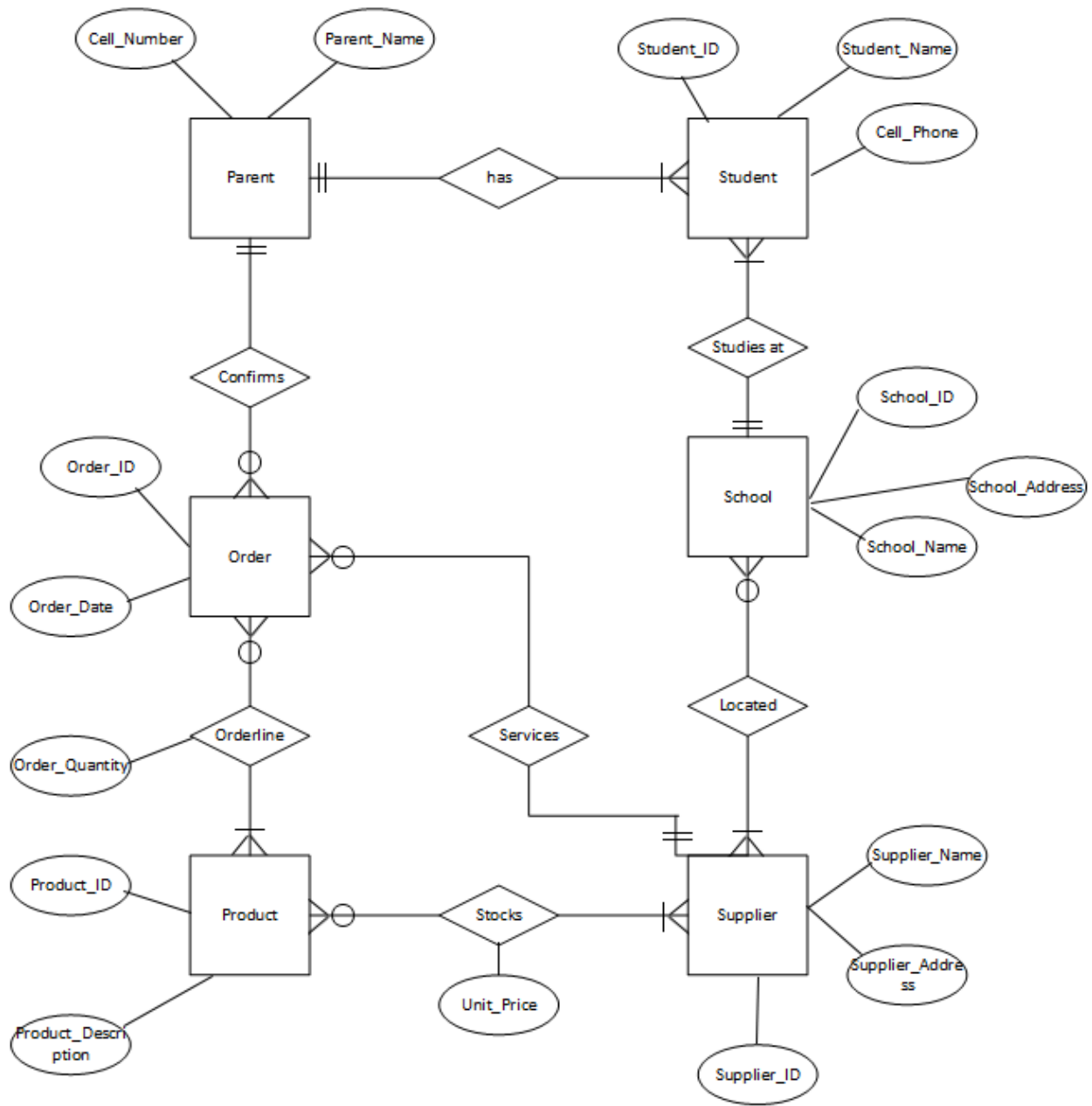


Figure 4.35 : Entity Relationship Diagram of the System

#### 4.4.7 Database

The system runs on MariaDB a fork of MySQL database and system database is hosted in the cloud; Linode cloud hosting services. Linode virtual private servers (VPS), while their product

line is not as robust as a “full-featured” cloud provider like Microsoft’s Azure or Amazon, it does have a breadth of services for very affordable price. Some the reasons that made the project go the Linode way were (UpGuard, 2017):

- I. Pay for what we use (utility services)
- II. Affordability
- III. Load balancing services may be added if needed
- IV. Scalability maybe added if needed
- V. Linode adds even more functionality by allowing for the installation of custom distros (very customizable) (Admin, 2019).

MariaDB, takes a fundamentally different database approach to fit today’s modern world. Its purpose-built storage engines support workloads that previously required a variety of specialized databases. Deployed in minutes for transactional, analytical or hybrid use cases, MariaDB delivers unmatched operational agility without sacrificing key enterprise features, including real ACID compliance and full SQL (MariaDB, 2019).

MariaDB is a fork of MySQL and was developed by the original developers of MySQL and guaranteed to stay open source. Notable users include Wikipedia, WordPress.com and Google. MariaDB turns data into structured information in a wide array of applications, ranging from banking to websites. It is an enhanced, drop-in replacement for MySQL. MariaDB is used because it is fast, scalable and robust, with a rich ecosystem of storage engines, plugins and many other tools make it very versatile for a wide variety of use cases (MariaDBFoundation, 2019).

#### **4.4.8 Web**

The web along with the static assets such as Style Sheets and site images such as logos are stored on a Linode cloud VPS, which is a virtual machine. The instance can be scaled up/down dynamically, which is good in terms of system growth and cost. The web system allows both external users such as parents, guardians and internal users such as system administrators to use the system. This web-based version is developed using the PHP programming language and is utilizing Laravel framework, which made development easy, enjoyable and fulfilling. Languages such as HTML, CSS 3 and JavaScript were used to allow for a great interactive user experience

on the site. A domain was bought straight from Godaddy a domain registrar company (Godaddy, 2019), and assigned to the web instance.

#### **4.4.9 API**

An API should allow communication of our system to external services, and also applications such as the mobile application. There is a bidirectional communication between the API and mobile application, due to the response-data-request cycle. An API also allows us to support multiple applications of different devices at once in future, since an API is device agnostic and only returns and consumes data in different formats. JSON is used as the consumption and return format, since it is lightweight in terms of bandwidth and easy to interpret in any language (Json.org, 2018).

Mobile applications at the least, require backend infrastructure to sync their data to and perform functions for users. That is why many expert application developers recommend having a web application that controls authentication hosted in cloud and then use a web API to link the mobile application. The project develops a robust backend for the mobile application by using the Laravel API on a cloud that does most of the backend processing. Laravel has a solid codebase and provides optimized performance for all lightweight and enterprise level applications (Rizwan, 2018).

Payments confirmation through MPESA involves communications to the Safaricom C2B MPESA API (Safaricom, 2018). The API returns SOAP responses, but that can be converted to JSON on our end.

#### **4.4.10 Mobile Application**

The mobile application should have been built for Android devices for the purposes of this project. The reason is that there are so many Android devices on the market compared to the other platforms (Dar & Parvez, 2014). However, the project used Ionic framework since the framework is an open source mobile User Interface toolkit for developing high-quality cross-platform apps for native iOS, Android, and the web—all from a single codebase (Ionic, 2019). This allowed the project to kill two or more birds with one stone. One code is rendered to run in Android, iOS and windows. Ionic framework come with the following advantages:

- I. It is platform independent whether it has to work with HTML, CSS, JS, or AngularJS.
- II. It helps in creating default mobile app UI functionalities easily and efficiently.
- III. It is wrapped by Cordova and PhoneGap.
- IV. It works on iOS's UI WebView or Android's WebView (Patel, 2019).

#### **4.4.11 Google Map and GPS**

Google Maps can display map images, topographic maps and satellite images, and can achieve global location search, classified information access, traffic information query, driving directions lines and even street scene three-dimensional model and so on. Besides this, Google also provides API to users for secondary development (Li & Zhijian, 2010). Google Maps API is coded in JavaScript while the web interface was created using Cake PHP framework, therefore the graphical and logical parts of the application have been separated (Babic, 2011). Google maps API provides many features for manipulating maps and adding content to the map through a variety of services that allows to create a mapping application. The project used Ionic Framework which uses the Apache Cordova project to build and run application as native mobile applications. Cordova provides over 200 plugins available as add-ons that enables the project to access native device APIs like the phone's camera, geolocation, gyroscope, and so on (Munyaka, 2019). GPS is a satellite navigation system whose signals can be used to compute three-dimensional position of a user located anywhere on or above the surface of the earth. It can be used to track location of the objects and individuals equipped with GPS receiver in an outdoor location (Sunehra et al., 2016). GSM is a worldwide standard used for cellular communication.

In this project the three technologies are integrated to achieve a context-aware system that is able to communicate the location of the request: the location of the school and hence based on this locate the suppliers that are located near-by the school. This gives the parent choices of suppliers with the least distance to the school hence the quickest delivery time to the school at a lower cost. This system also enables easier tracking of commodities on the way school from the suppliers. Figure 4.36 depicts a sample block diagram of GPS component of the system with a central tracking system of the delivery personnel from a central office.

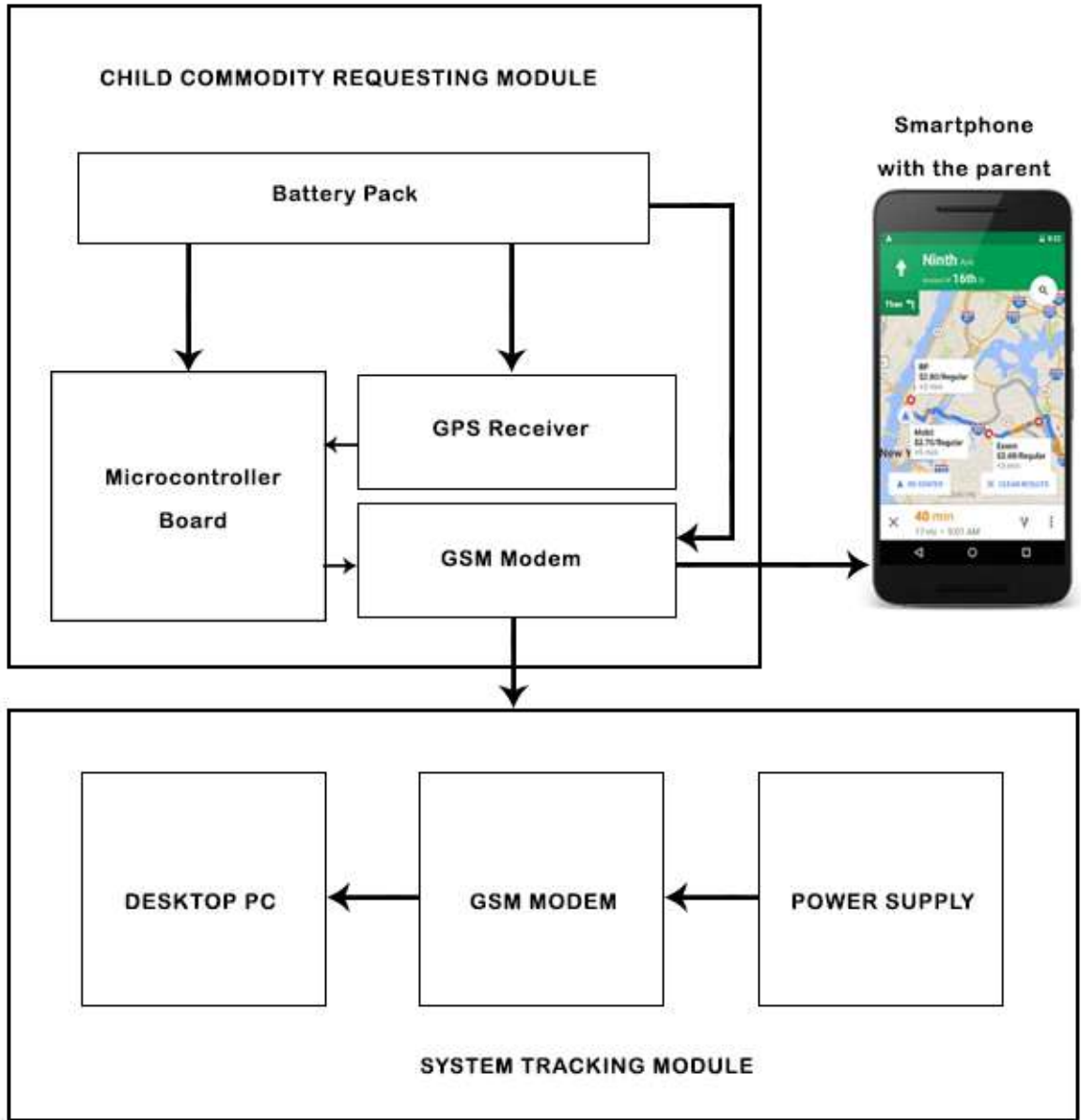


Figure 4.36 : Block Diagram of GPS Component of the System

## Chapter 5 : System Implementation and Testing

### 5.1 Introduction

The literature review discussed in *Chapter Two* and the research finding in *Chapter Four* of this project formed the basis of the development of location-based commodity ordering and delivery system. This is the actual realization of the platform and testing of the same to ensure that it delivers the services the project designed it for. According to Slevin (1987), Project implementation involve the successful development and introduction of the project in an organization. This is the successful production of the project and performance capabilities verified (Slevin, 1987). By verification in this context, Slevin (1987) meant testing of the project to ensure that functional requirements discussed in chapter 4 are met. System testing, defined by the Economic Times (2019) as testing of a complete and fully integrated software product System testing is performed in the context of a System Requirement Specification (SRS) and/or a Functional Requirement Specifications (FRS) (Times, 2019). It is the final test to verify that the product to be delivered meets the specifications mentioned in the requirement document. It should investigate both functional and non-functional requirements (The Economic Times, 2019).

### 5.2 System Implementation

#### 5.2.1 Work Flow

##### 5.2.1.1 Normal Request

Working booths are setup in registered schools at the merchant's costs for use by the students. The student initiate a request by choosing products and sending a request. The parent receives a notification with the name of the child and school of the child. The parent is able to look through the order to check line items. They are able to edit the order or add other products. Ones satisfied, the parent confirms the order. The order is broadcasted to the suppliers registered in the system that are closest to the school. They also receive notification in their emails.

The suppliers go through the order to see if they have all the items that is listed in the order. If they have all items, they accept the order. A notification is sent to parent that a supplier has been

assigned to their order. The parent then commits to the order by making payment to the merchant account. A clearance of payment notification is sent to the supplier with the order giving them green-light to deliver the order. The supplier dispatches the order after assigning a delivery person to the order and estimating the delivery time of the order. The estimated time helps the parent, student and the school administrator to track the order and plan for receipt of delivery.

### **5.2.1.2 Request Initiated by the Parent**

In special cases where for one reason or the other; for instance, maybe the student went back to school when the parent did not have enough money to buy all requirements: the parent may order these products by themselves since they know the products that the student went back to school without. In this case the parents put in an order and it goes straight to the suppliers as the parent is the approvers of the orders and they need not approve their own orders. The order is broadcasted to the suppliers registered in the system and the order follows the work flow similar to one in 5.2.1.1 second paragraph.

The student will be able to see the order placed by the parent in *Order Status* Module where they are able to track when it was created, the suppliers assigned to the order and the expected delivery date. If the student does not check the orders, then they will have to rely on the school administrator to notify them of their order

## **5.2.2 Application Hardware Requirements**

### **5.2.2.1 Server Specifications**

The system is running on a 2GB RAM and 50GB hard disk VPS server. The VPS is procured from Linode cloud hosting services. Among, other reasons, the main reason the project settled for the Linode is the malleability and the fact that the server is very customizable (Admin, 2019). A developer can choose a MySQL and PHP version that they want to run in the server. The server's performance is very good and at an affordable price (Admin, 2019).

The server runs Linux 64 bit operating system and Nginx as the web server of choice. Nginx has grown in popularity since its release in 2004 due to its light-weight resource utilization and its ability to scale easily on minimal hardware. Nginx is a high performance and high throughput

webserver that is highly customizable. The web server, excels at serving static content quickly and is designed to pass dynamic requests off to other software that is better suited for those purposes (Community, 2019).

Nginx is often selected by administrators for its resource efficiency and responsiveness under load. NGINX was written specifically to address the performance limitations of Apache web servers. It was created in 2002 by Igor Sysoev, a system administrator for a popular Russian portal site (Rambler.ru), as a scaling solution to help the site manage greater and greater volumes of traffic. The performance and scalability of NGINX arise from its event-driven architecture. It differs significantly from Apache's process-or-thread-per-connection approach – in NGINX, each worker process can handle thousands of HTTP connections simultaneously. This results in a highly regarded implementation that is lightweight, scalable, and high performance (Garrett, 2019). With above in mind, to avoid scalability issue in future, the project went for NGINX instead of Apache for the web server.

#### **5.2.2.2 Mobile Application**

The mobile application is compiled to run in iOS and Android. The version of Android supported is 5.5(Lollipop) and above.

#### **5.2.3 Application Software Requirements**

##### **5.2.3.1 Framework**

The project employed Laravel Framework in the development of the web application section of the project. The framework is highly modularised code that conforms to modern day web development standards and fully object oriented therefore encouraging high code reuse. Laravel framework is fully compatible with the PHP composer package manager and this makes using code written by other developers easier and safer (Alfat & Triwiyatno, n.d.; Anif, Dentha, & Sindung, 2017).

##### **5.2.3.2 Language**

As mentioned in the previous chapters, PHP was chosen for the project for various reasons including the fact that it can run in very inexpensive development environments. It is one of the

most popular languages with some 244 Million websites being developed in PHP by 2013 (Jevremovi, Risti, & Veinovi, 2013). PHP is also one of the fastest language in managing database which is key for the success of this system (Bounnady & Phanthavong, 2016). Furthermore, it is also easy to learn and customise.

### **5.2.3.3 JavaScript**

The project used VueJS as the JavaScript framework in the development of the system. The framework makes it possible to bring interactivity to web pages with very minimal code (Administrator, 2019).

### **5.2.3.4 Webpack (asset building)**

Webpack, an open-source JavaScript module bundler is used to make it easier to consolidate assets such as SASS, JavaScript and VueJS files into well modularized libraries. The end result is that it is easier to build a frontend interface

### **5.2.3.5 Ionic**

Ionic is an open source, cross-platform framework/ UI toolkit for developing high-quality cross-platform/hybrid mobile applications for native iOS, Android, and the web—all from a single codebase (Ionic, 2019). Ionic is a mobile application development framework based on the HTML5 programming language. Ionic Framework makes it possible to use familiar web technologies and improves a developer productivity when it comes to setting up an app quickly from scratch.

### **5.2.3.6 MariaDB (10.2)**

The project sought the services of MariaDB, a fork of MySQL, meaning the database structure and indexes of MariaDB are the same as MySQL (Sarig, 2018). The main reason behind this choice instead of MySQL is that MariaDB include GIS and JSON features. MariaDB is developed as open source software and as a relational database it provides an SQL interface for accessing data. MariaDB is used because it is fast, scalable and robust, with a rich ecosystem of storage engines, plugins and many other tools make it very versatile for a wide variety of use cases (MariaDBFoundation, 2019).

## 5.2.4 System Users and Graphical User Interface

### 5.2.4.1 Landing/Home Page

The web graphical user interface of the system have the landing page shown on Figure 5.1. The mobile application graphical user interface landing page of the system, have the landing page shown on Figure 5.2. The user is able to register if they are not already registered or login to their profile if they already have an account in the system.

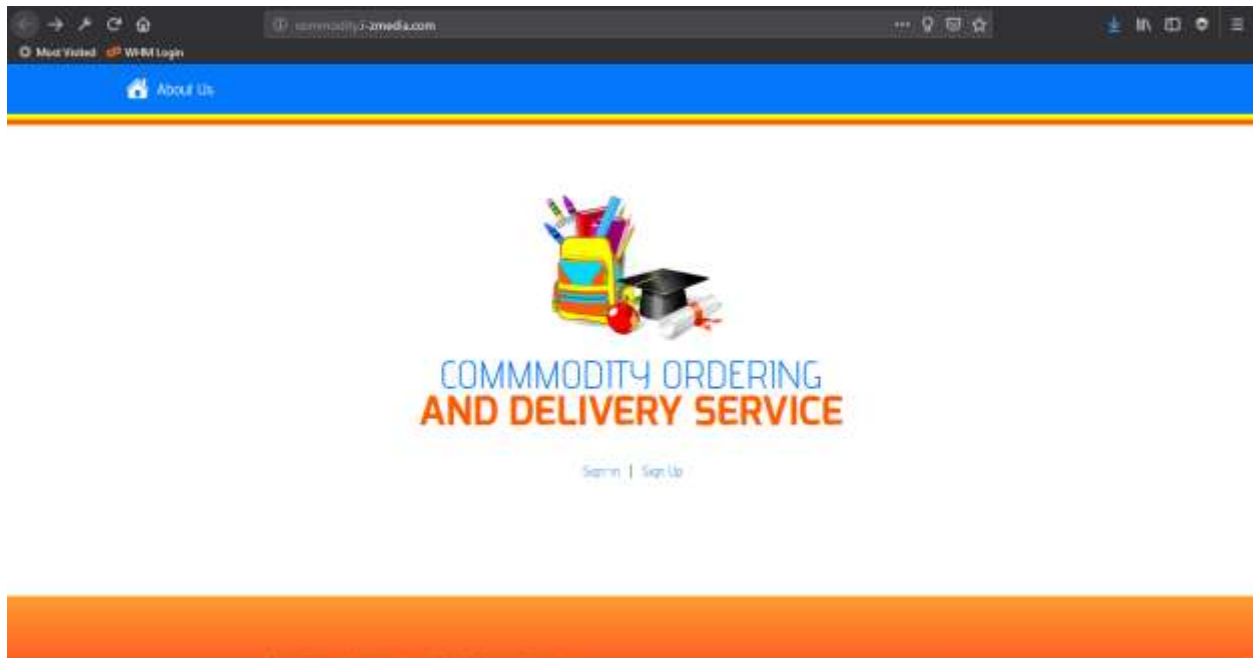


Figure 5.1 : Web Interface of the Landing Page for Commodity Ordering and Delivery Service

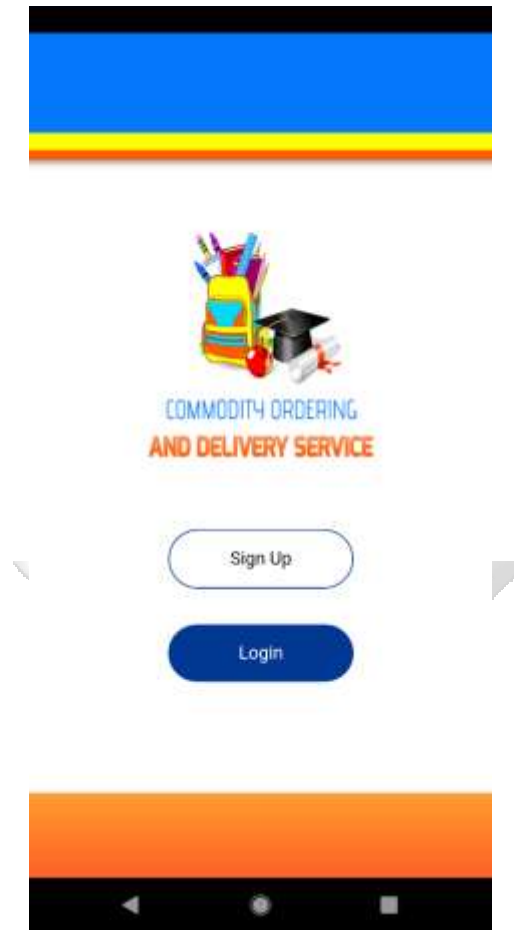


Figure 5.2 : Mobile Interface of the Landing Page for Commodity Ordering and Delivery Service

#### 5.2.4.2 Sign-In Page

The login page of the system is as shown on the Figure 5.3 for the web interface and Figure 5.4 for the mobile interface. Basically the user first chooses their roles: whether they are parents; student; school administrator; supplier or delivery person(s). All users are able to login using their email address as the username except for the student who logs-in using student ID. This interface also has a link to password change interface, in case the user has forgotten their password. Password reset email is sent to the user email address in case the user uses this provision.



**COMMODITY ORDERING  
AND DELIVERY SERVICE**

User Category

Email/Admission Number

Password

Figure 5.3 : Web Interface Sign-in Page

For the phone interface, the user have an option to check whether they want the system to remember them once they have logged in. This saves them time on having to login every time they want use the mobile application.

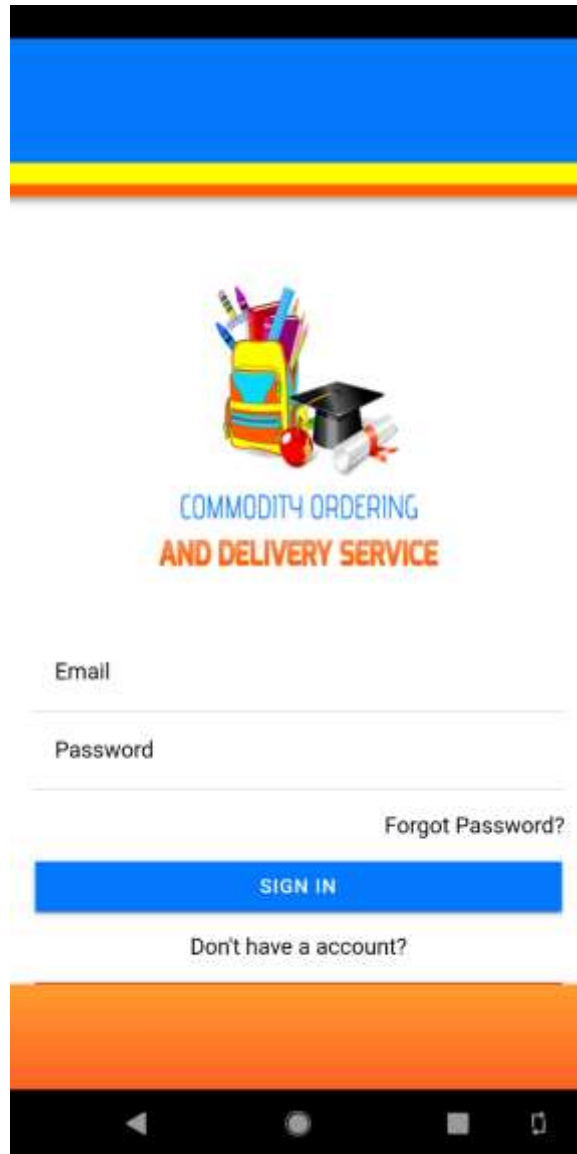


Figure 5.4 : Mobile Interface Sign-in Page

### 5.2.4.3 Sign-Up page

The web signup page is as illustrated in Figure 5.5. The mobile sign up page looks as illustrated in Figure 5.6. The account types on creation are three: Parent; Supplier; and School Administrator. The parent is able to add their children (boarding students) and this is how student accounts are created. The supplier can add delivery person(s) and hence the account of the delivery person is created.

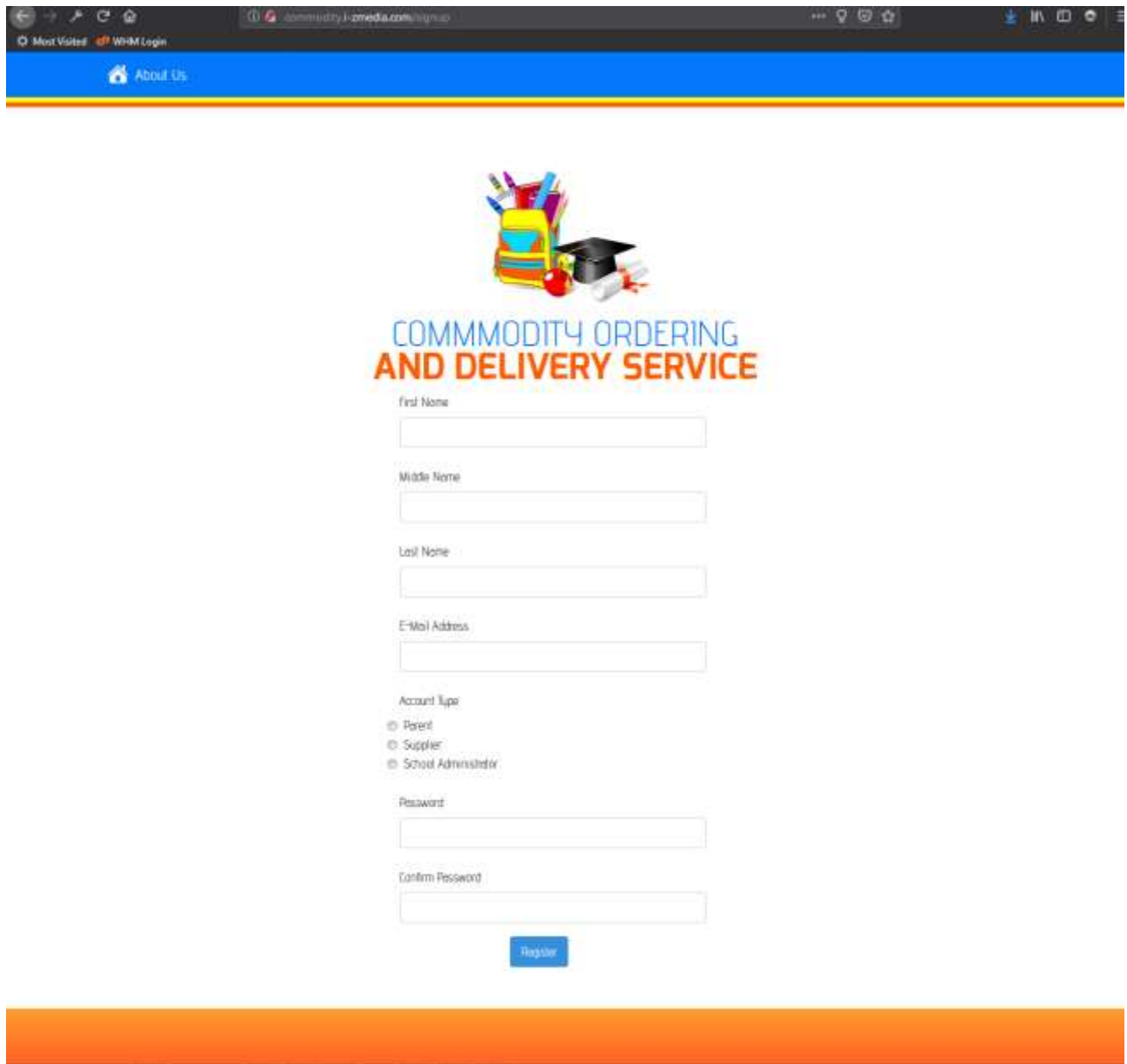


Figure 5.5 : Web Sign-up page

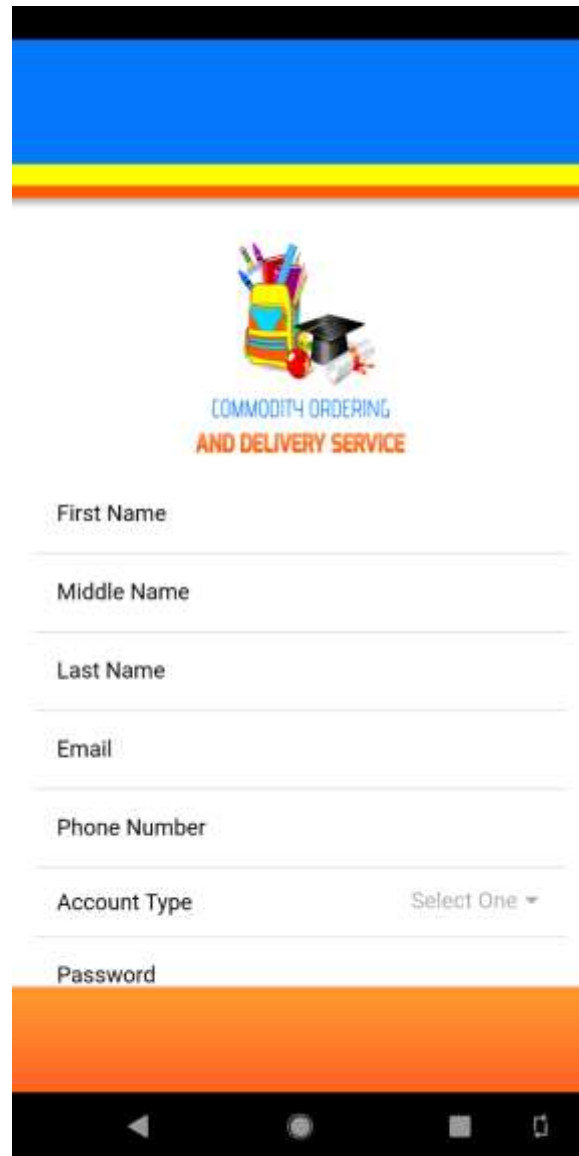


Figure 5.6 : Mobile Sign-up page

#### 5.2.4.4 User Roles

- I. **Parent:** Uses the system to order delivery to be made to their children in boarding school.
- II. **Supplier:** Uses the system to sell their product to parents of children in boarding schools
- III. **School Administrator:** Uses the system to check the products ordered by the students, and communicate to the parents
- IV. **Student (In Boarding schools):** Uses the system to make request to their parents or caregivers about the need(s) that they have while in school.

- V. **Delivery Person:** Uses the system to broadcast their location as they make delivery to schools. They also use the system to guide them via google map to the school that delivery is to be made.

### 5.2.5 Main Modules and Graphical User Interface

The system has graphical user interface dashboards for every user role that uses the system since each user interacts with the system through different modules.

#### 5.2.5.1 Parents Dashboards

Parent's dashboard is as illustrated in Figure 5.7. The following are explanations of the modules in the parent dashboard:

- I. **Edit Profile:** This module enables a parent to update their profile with new information and add children in boarding school or delete a child from their list.
- II. **Initiate a Request:** This module enables a parent to initiate a request instead of a child/student. Here they select the products that they would like to be delivered to their children and search the closest commodity supplier, make the order and confirm the order.
- III. **Confirm the order:** This is where the request initiated by the student is verified by the parent before being confirmed. The parent gets a notification and logs in to view the request. They are able to edit the request to remove or add some products from the list and confirm the order or reject the request totally.

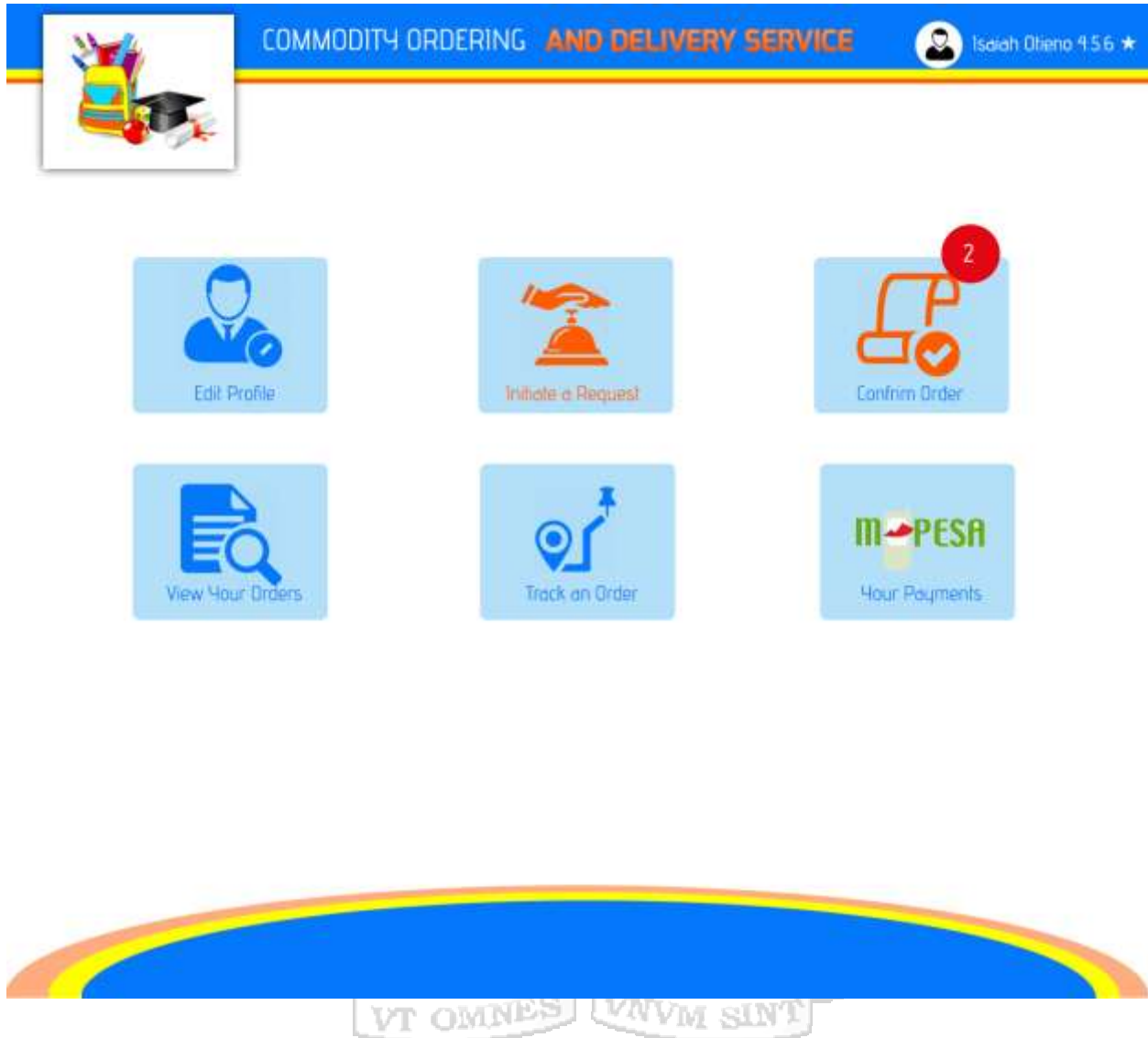


Figure 5.7 : Parent Profile Dashboard - Web Impression

- IV. **View Your Orders:** This module enables the parent to see the history of their previous orders. They can therefore deduct a trend from the pattern of their children orders
- V. **Track Order:** The module enable the parent to track the delivery person in real time if the delivery person’s mobile is online (connected to the internet) and the app is activated. The parent gets the delivery person’s name and mobile number to call them just in case communication is needed.
- VI. **Your Payments:** this module is the billing module with history of all previous payments made.

### 5.2.5.2 School Administrator's Dashboards

School administrator's dashboard is as illustrated in Figure 5.8. The following are explanations of the modules in the school administrator's dashboard:

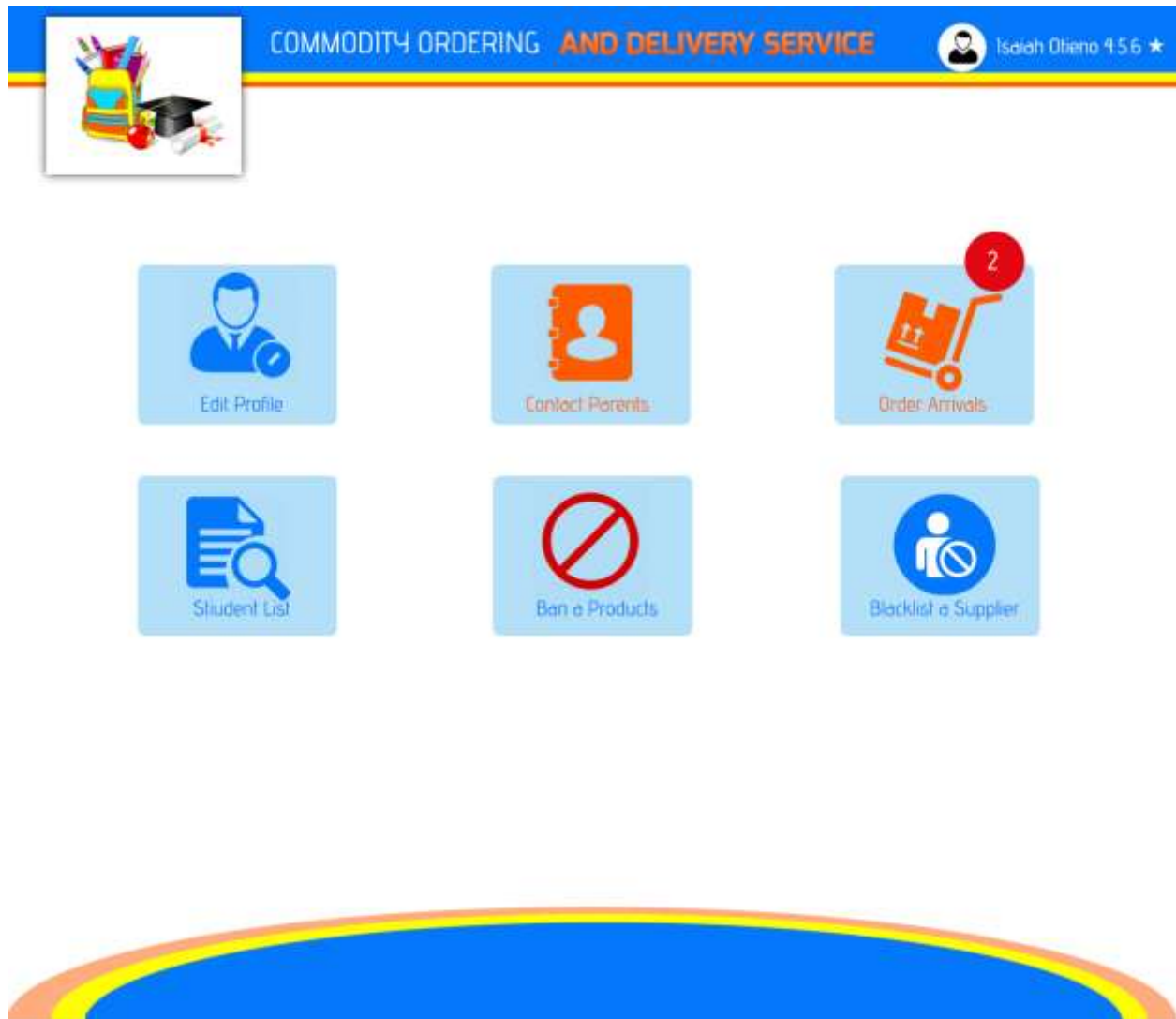


Figure 5.8 : School Administrator Profile Dashboard - Web Impression

- I. **Edit Profile:** The module enables school administrators to update the school profiles with new information.
- II. **Contact Parents:** This module has the list of all the parents that are registered in this system and have children in the school in question. The school administrator is

able to see all their mobile numbers and be able to send them emails. The emails can be sent to individual parents or as bulk email that goes to all parents of the school.

- III. **Order Arrivals:** the module is for information purposes just to inform the administrator that certain orders will be delivered on this date and approximate time of delivery. It also have the name of the student who the order is for.
- IV. **Student List:** The administrator is able to see all students who are registered in this system and their class/form. It also has information on the parent of the child
- V. **Ban a product:** This module enables an administrator to add a product/item to a list of “banned items”. These are items that are not allowed in school and the student should not be able to order them in the first place. Any product in this list is not available for the students or parent of this school to order.
- VI. **Blacklist a Supplier:** The school might not be happy by the way a certain supplier delivered the commodity or if they did not follow the agreed upon school rules. In this case the administrator should be able to suggest a blacklist of this supplier but it’s the main administrator of the system who is able to blacklist the supplier

### 5.2.5.3 Commodity Supplier Dashboards

Commodity supplier’s dashboard is as illustrated in Figure 5.9. The following are explanations of the modules in the supplier’s dashboard:

- I. **Edit Profile:** The module enables the commodity supplier to be able to update the supplier profile with new information about the shop and the location of the shop. The system uses this location when searching for suppliers nearer to the school.
- II. **Track Order:** The module enables the supplier to track their delivery person in real time if the delivery person’s mobile is online (connected to the internet) and the application is activated.
- III. **Update Catalogue:** It allows the commodity supplier to populate new products into the system for the parents and students to order. The catalogue is dynamic in the sense that if the supplier has the 3 blankets and the 4 parents orders the blanket, the last parent to order is told that the blanket is out of stock.

- IV. **Previous Supplies:** The suppliers are able to see the history of their supplies; to which schools and at what cost from this module. They can use this data to identify trends in the ordering sequence of students in their areas.
- V. **Delivery Person:** The commodity suppliers is able to register their delivery personnel through this module. The system captures the delivery persons Full Names, National Identity Card and their phone Number and Email address. The delivery person uses their phone numbers and password which is set by the supplier when registering them to login to the system

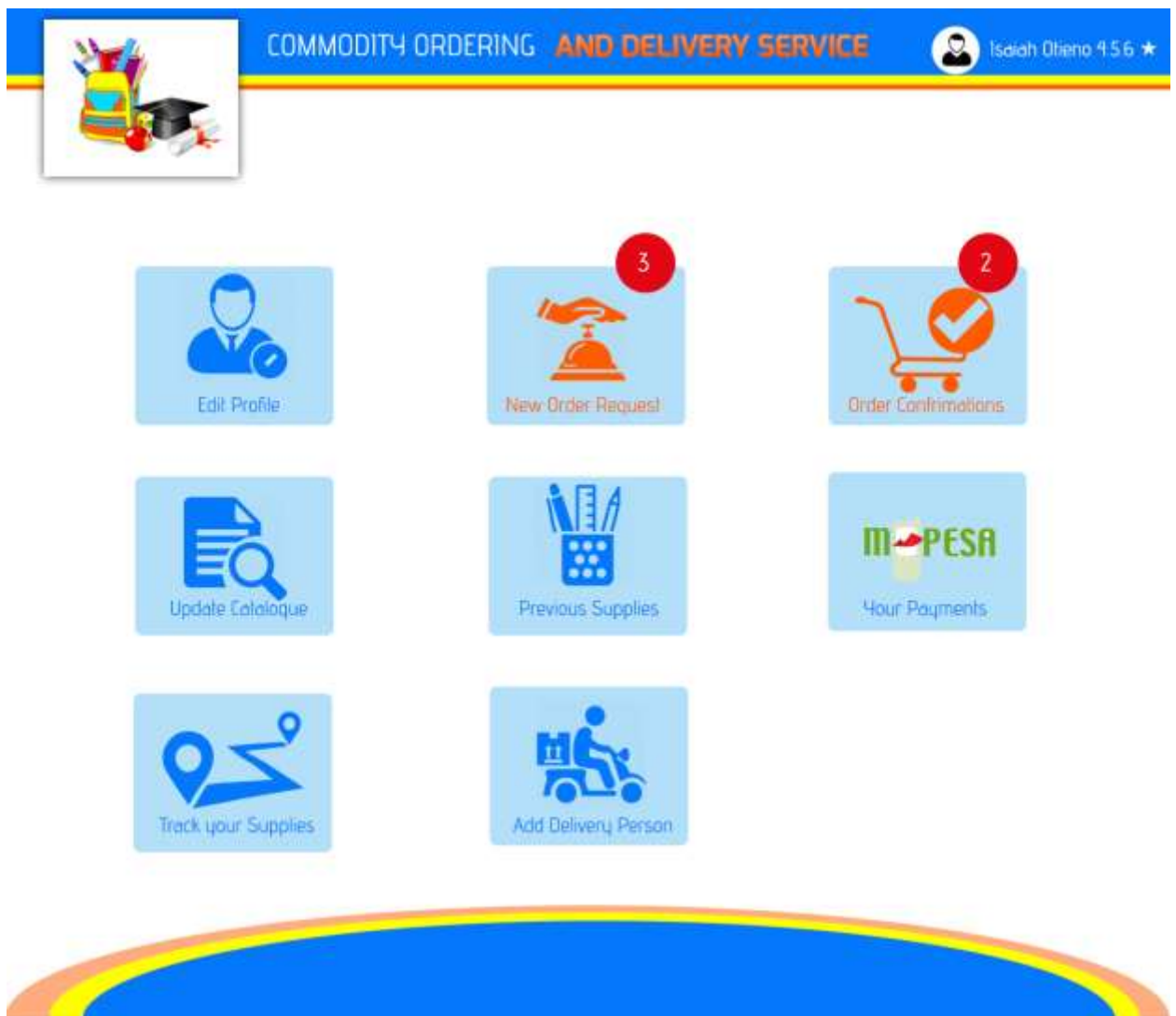


Figure 5.9 : Commodity Supplier Profile Dashboard - Web Impression

- VI. **New Orders Request:** This module gives the supplier access to request by parents checking the availability of products in stock. When they confirm that they have products is when the parent can confirm delivery by committing payment to the merchant account.
- VII. **Order Dispatch:** This concerns orders that have been confirmed by the parent for delivery to the school. This means that the parent has committed the funds to system and are released to supplier the moment delivery is confirmed.

#### 5.2.5.4 Student Dashboards

Commodity student's dashboard is as illustrated in Figure 5.10. The following are explanations of the modules in the student's dashboard:

- I. **Initiate a Request:** A student starts the workflow by putting up a request to their parent through this module by selecting the products that they need in school. It is up to the parent to approve the request or approve with amendments.
- II. **View your Orders:** The students are able to see the history of their orders/transactions from this module.
- III. **Change Password:** Student is able to change password from here
- IV. **Order Status:** The student is able to see if the parent has edited the order, approved it, rejected it; whether the order is with the commodity supplier and how many days or hours to delivery
- V. **Confirm Order:** When the student receives the delivery, they must login to the system and confirm delivery, so that funds are released to the supplier

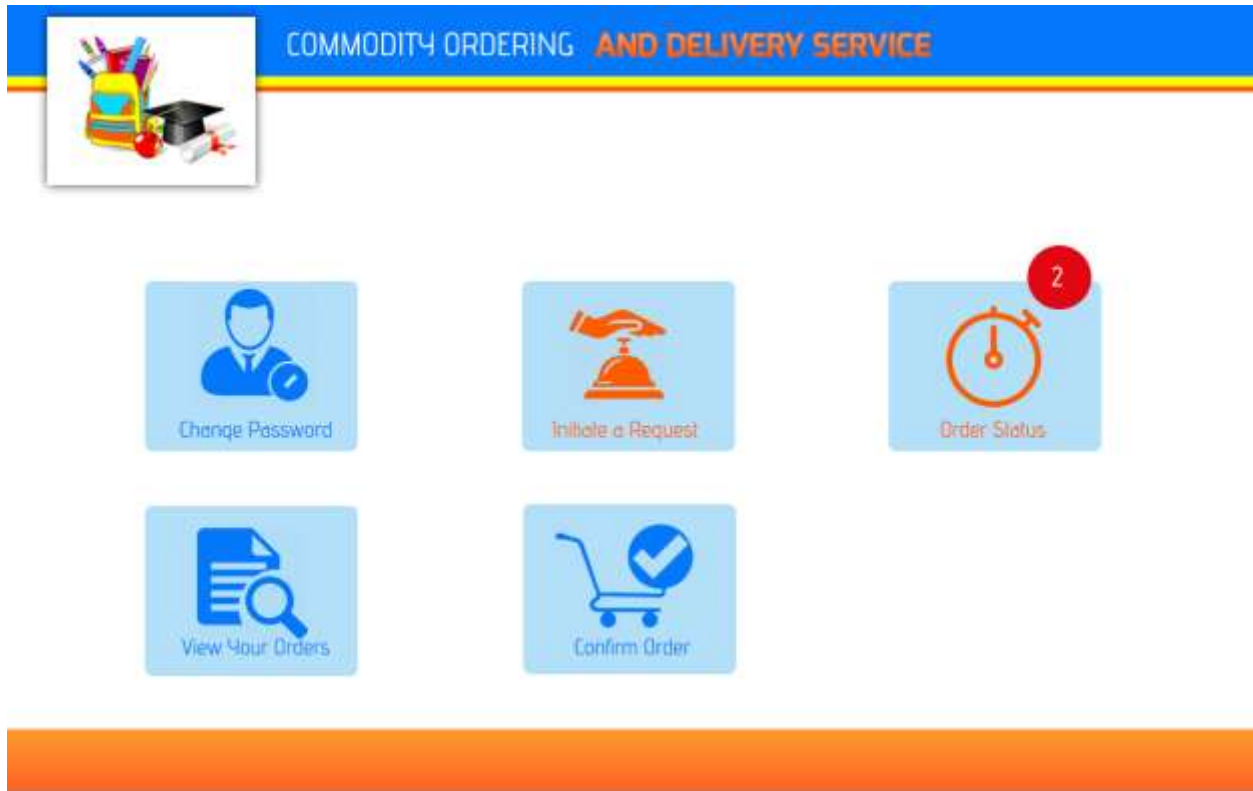


Figure 5.10 : Student Profile Dashboard - Web Impression

#### 5.2.5.5 Delivery Person Dashboard

The delivery person when logged in will see a list of all the deliveries assigned to them by the supplier as illustrated in Figure 5.11. They will click on any of the deliveries to launch the google map that shows them the direction to the school that the delivery is to be made.

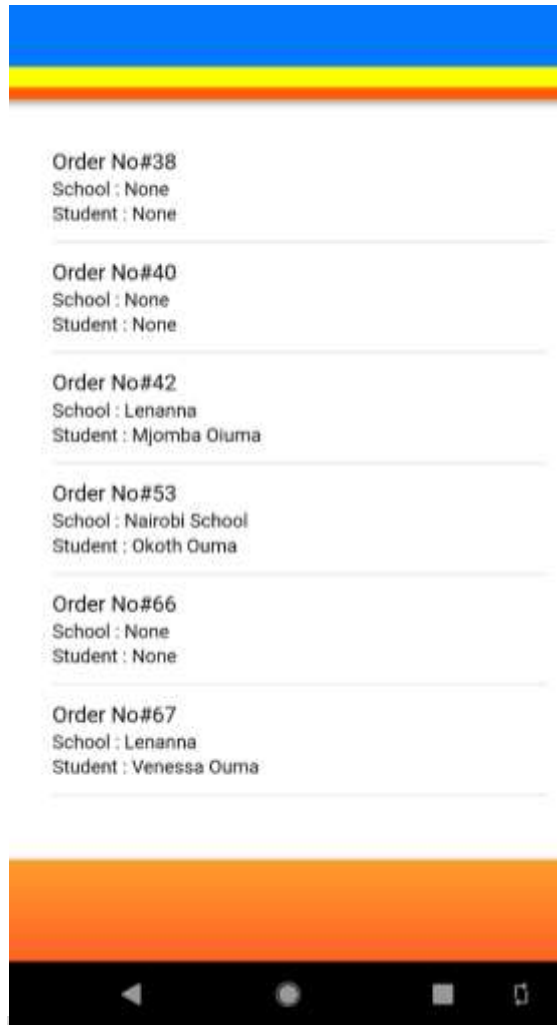


Figure 5.11 : Delivery Person's Dashboard - Mobile Impression

Figure 5.12 show the map that launches when the delivery person selects a certain order to drop.

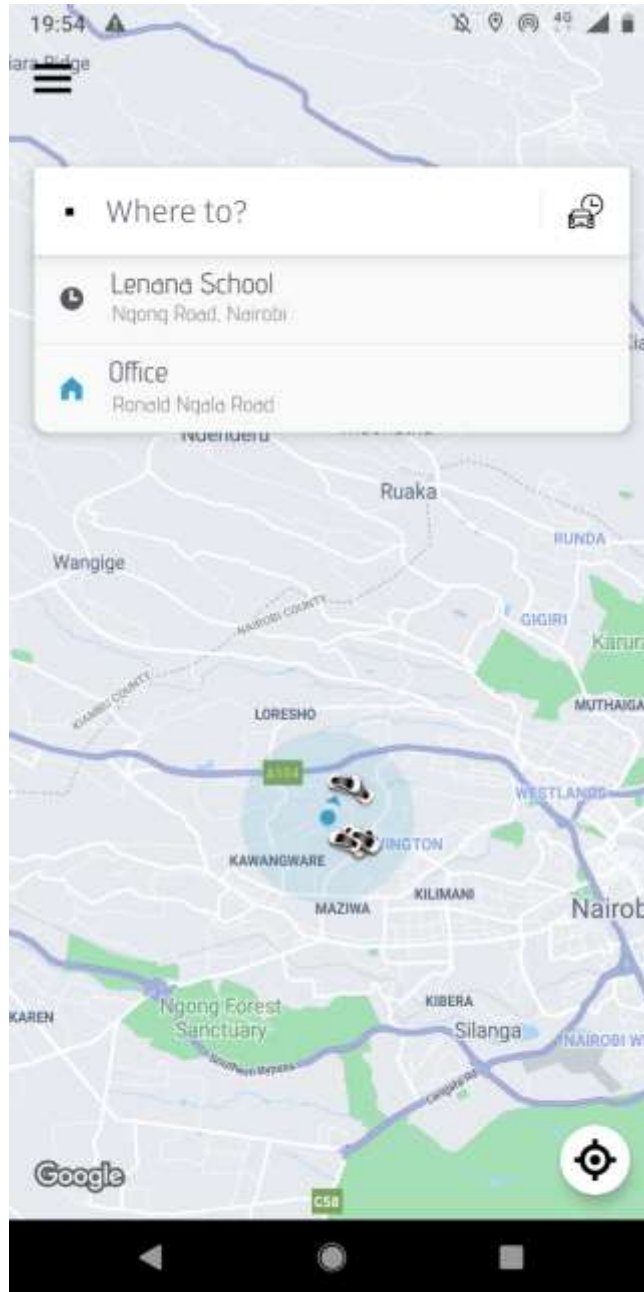


Figure 5.12 : Delivery Person's Direction Map - Mobile Impression

## 5.3 System Testing

### 5.3.1 Functional Testing

The platform was tested to validate that all functions were captured as described in chapter four of this work. Table 5.1 gives an overview of the test variables and the results.

Table 5.1 : Functional Testing Variables and Results

Test Class	Inspection Check	Priority level	Test Results
Functional	Does the system capture User data and save it for future use with system	High	Pass
Functional	Does the system enable students request commodity from their parents	High	Pass
Functional	Does the system enable parents order commodity from supplier	High	Pass
Functional	Does the system help suppliers sell their commodity through the system	High	Pass
Functional	Does the system help parents make payment instantly through MPESA	High	Pass

<b>Functional</b>	Does the system Generate parent and student list	High	Pass
<b>Functional</b>	Does the system enable the school administrator to send email(s) to parents	High	Pass
<b>Functional</b>	Does the system employ google Maps to register school Location, Supplier Location and to track the delivery person successful	High	Pass
<b>Functional</b>	Does the system protect the identity of the child to the supplier and the delivery person	High	Pass
<b>Functional</b>	Does the system automatically update the stock levels of the supplier products and help the parent locate the supplier closest to school	High	Pass
<b>Non- Functional</b>	Is the system intuitive enough for all stakeholder to navigate without issues	High	Pass

<b>Non- Functional</b>	Is the system fault tolerant enough to withstanding confusing commands from clientele that is not tech-savvy	Moderate	Pass



### 5.3.2 Prototype Validation Results

The project divided the action into the general actions as shown on table 5.1 that all users has to go through and later divided the action per user according to the dashboard of the user in question.

Table 5.2 : General User Actions

Step	Action	Expected Response	Comments
<b>1.0</b>	<b>User Registration</b>		
1.1	A user selects Sign-Up	A new window with input fields for creating a new member is presented to the user	Pass
1.2	User makes Invalid Data entry	Error Dialog box	Pass
1.3	User leaves out a Mandatory Field	Error Dialog box	Pass
1.4	User submits details	The registration status is turned to “Registered”  User receives an automatic email from the system	Pass
<b>2.0</b>	<b>User Login</b>		
2.1	A user selects Sign-In	A new window with input fields for logging in is presented to the user	Pass
2.2	Registered user enters Correct User Type Username and Password	A user is presented with the right user dashboard	
2.3	User leaves out a Mandatory Field	Error Dialog box	Pass
2.4	User makes Invalid Data entry	Error Dialog box	Pass

The parent user is one of the main stakeholder of the platform. Table 5.2 show actions that pertain the parent user dashboard.

Table 5.3 : Parent User Actions

Step	Action	Expected Response	Comments
<b>1.0</b>	<b>Edit Profile</b>		
1.1	A user selects edit Profile menu	A new window with input fields for Updating Profile is presented to User	Pass
1.2	User is able to add a child (up to 5 children)	On clicking Add Child, A user is presented with fields for Adding new Child	Pass
1.3	User is able to delete a child	On Clicking Delete Child (In case a child has finished school), the user is able to delete a child from his profile	Pass
<b>2.0</b>	<b>View Orders</b>		
2.1	A user selects View Orders Menu	A new window with Previous orders is presented to user.	Pass
2.2	A user selects View Details on an Order	A dialogue box is presented with order line items and the supplier of the order	Pass
<b>3.0</b>	<b>Initiate Request</b>		
3.1	A user selects Initiate Request Menu	A new window with Add Product button presented to user.	Pass
3.2	A user selects Add Product Button	A user is presented by a Dialogue box for selecting Products	Pass
3.3	A user selects place order.	The system looks for the closed supplier to the school gives the order to them for supplier to confirm the order	Pass
<b>4.0</b>	<b>Confirm Order</b>		

4.1	A User selects Confirm Order from Menu	A user is presented by Order request made by the student/ Child in school.	Pass
4.2	A user selects Modify Oder	The user is presented by a dialogue box where they are able to edit the order the child made	Pass
4.3	A user selects Confirm Oder	<p>I. The system looks for the closed supplier to the school gives the order to them for supplier to confirm the order</p> <p>II. The user is redirected to make payment module. They enter their MPESA PIN and an amount commensurate to the cost of order is transferred to the merchant account.</p> <p>III. The amount is released to supplier only when there is confirmation of delivery either from the School Administrator or from the student</p>	Pass
4.4	A user selects Reject Oder	The order is closed without being sent to the supplier	Pass
<b>5.0</b>	<b>Track An Order</b>		
5.1	A User selects Track an Order from Menu	A user is presented by Google Map where they are able to track the delivery person in real time.	Pass
<b>6.0</b>	<b>Your Payments</b>		
6.1	A User selects Your Payments from Menu	A window with previous payments is presented to the user	Pass

	A user Selects View Details	A dialogue box with order number, student name and the amount is presented to the user	Pass
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The supplier user is another main stakeholder of the platform. Table 5.3 show actions that pertain to the supplier user dashboard.

Table 5.4 : Supplier User Actions

Step	Action	Expected Response	Comments
<b>1.0</b>	<b>Edit Profile</b>		
1.1	A user selects edit Profile menu	A new window with input fields for Updating Profile is presented to User.	Pass
1.2	Select Shop Location on Google Map	The user is able to select the location of the shop on the google Map. The location is saved and used by the system to get the supplier on parents requests	Pass
<b>2.0</b>	<b>New Order Requests</b>		
2.1	A user selects New Order Request from Menu	A new window with all parents orders is presented to user	Pass
2.2	The user selects View Details	A dialogue box with line items for the order is presented.	Pass
2.3	User Selects Accept Order	If all line items are available on the suppliers stock, the user selects Accepts Order. The order is returned to the Parent to confirm and, commit payment.	Pass
2.4	User Select Return Order	If Supplier does not have items on the order, they click return order so that the system can look for another supplier.	Pass
<b>3.0</b>	<b>Update Catalogue</b>		

3.1	A user selects Update Catalogue from the Menu	<ul style="list-style-type: none"> <li>I. A new window with input fields to add new product to the stock of the supplier is presented to them.</li> <li>II. The supplier is able to see products that are still in stock and the numbers still remaining</li> <li>III. As products re bought from Supplier, the numbers in stock are reduced automatically.</li> </ul>	Pass
<b>4.0</b>	<b>Order Confirmations</b>		
4.1	A user selects Order Confirmations from the Menu	A new window with orders that have been approved by the parents and funds committed through MPESA are listed	Pass
4.2	User Selects Initiate Delivery	<ul style="list-style-type: none"> <li>I. The delivery person starts the journey of delivery products to the school.</li> <li>II. Once Delivery confirmation is received for a particular order, the order is automatically moved to Previous Orders</li> </ul>	Pass
<b>5.0</b>	<b>Previous Orders</b>		
5.1	A user selects Previous Orders Menu	A new window with Previous orders is presented to user.	Pass
5.2	A user selects View Details on an Order.	A dialogue box is presented with order line items and the parent/customer who paid for the order	Pass
<b>6.0</b>	<b>Track An Order</b>		
6.1	A User selects Track an Order from Menu	A user is presented by Google Map where they are able to track the delivery person in real time.	Pass
<b>7.0</b>	<b>Your Payments</b>		

7.1	A User selects Your Payments from Menu	A window with previous payments is presented to the user	Pass
	A user Selects View Details	A dialogue box with order number, parent name and the amount is presented to the user	Pass
<b>8.0</b>	<b>Add Delivery Person</b>		
8.1	A user selects Add Delivery Person Menu	A window with fields for adding a delivery person is presented to the user	Pass
8.2	User is able to add a delivery person(s) (up to 5)	On clicking Add Child, A user is presented with fields for Adding new Child	Pass
8.3	User is able to delete a delivery person	On Clicking Delete Delivery Person, the user is able to delete a delivery person from their profile	Pass

The student user is one of the main stakeholder of the platform. Table 5.4 show actions that pertain to the student user dashboard.

Table 5.5 : Student User Actions

Step	Action	Expected Response	Comments
<b>1.0</b>	<b>Change Password</b>		
1.1	A user selects Change Password from the Menu	A new window with input fields to change Password is presented to them.	Pass
<b>2.0</b>	<b>Initiate Request</b>		
2.1	A user selects Initiate Request Menu	A new window with Add Product button presented to user.	Pass
2.2	A user selects Add Product Button	A user is presented by a Dialogue box for selecting Products	Pass

2.3	A user selects place order.	The system looks for the closed supplier to the school gives the order to them for supplier to confirm the order	Pass
<b>3.0</b>	<b>View Orders</b>		
3.1	A user selects View Orders Menu	A new window with Previous orders is presented to user.	Pass
3.2	A user selects View Details on an Order	A dialogue box is presented with order line items, date of delivery and the supplier of the order	Pass
<b>4.0</b>	<b>Order Status</b>		
4.1	User Selects Order Status	A window un-delivered orders is presented to the user	Pass
4.2	User Selects View details	A dialogue box with details of who the order is with on the workflow is presented to the user. If parent have not confirmed the order, the student sees this. If the delivery person has initiated the delivery, student sees details of expected delivery date.	Pass
<b>5.0</b>	<b>Confirm Delivery</b>		
5.1	A user selects confirm Delivery	A user is presented with a windows of un confirmed delivery. By clicking on confirm delivery, payment is made to the supplier automatically from the merchant.  Student is able to rate the supplier at this point. It is optional	Pass

The school administrator is another one of the main stakeholder of the platform. Table 5.5 show actions that pertain to the school administrator user dashboard.

Table 5.6 : School Administrator User Actions

Step	Action	Expected Response	Comments
<b>1.0</b>	<b>Edit Profile</b>		
1.1	A user selects Edit Profile menu	A new window with input fields for Updating Profile is presented to User.	Pass
1.2	Select School Location on Google Map	The user is able to select the location of the school on the google Map. The location is saved and used by the system to get the closest supplier to the school when request is made	Pass
<b>2.0</b>	<b>Contact Parents</b>		
2.1	User selects Contact Parents Menu	A window with fields for writing an email is presented to the user <ul style="list-style-type: none"> <li>I. If the user check the checkbox of send to all parents, the email is sent to all parents</li> <li>II. A user can choose from a drop down to send an email to a specific Parent or parents</li> </ul>	Pass
<b>3.0</b>	<b>Ban a Product</b>		
3.1	User selects Ban Products from the menu	A window with fields to list the products that are not allowed in school is presented.  If a user enters a product to this list, the students/parents are not able to see the product on their catalogue hence the product are not available to be ordered	Pass
<b>4.0</b>	<b>Student List</b>		

4.1	A user selects Student List from the menu	A windows with students from the school in question listed, with their names, class, dormitory name presented to the user	Pass
<b>5.0</b>	<b>Blacklist Supplier</b>		
5.1	A user selects Black List Supplier from the menu	A window with field to select the registered supplier is presented	Pass
5.2	Select a Supplier to Black List	A dialogue box for selecting a supplier to black list is presented to user. The selection is just a proposal to the main administrator to add the supplier to blacklist. Only main administrator can blacklist supplier	Pass
<b>6.0</b>	<b>Order Arrivals</b>		
6.1	A user selects Order Arrivals from the menu	A window displaying all undelivered orders to the school is presented to the user.	Pass
6.2	User Selects View Details	A dialogue box with detail of the delivery arrival date and time and the name of the delivery person is presented to the user	Pass
6.3	User selects Confirm Delivery	The delivery status changes to confirmed and the payment is made automatically to the Supplier MPESA account	Pass

### 5.3.3 Usability Testing

The project analysed the usability of the system carefully considering the various key stakeholder of the system. Acknowledging that some parents are not technology savvy and the fact that most school administrators preferred a web based system to mobile application, the project decide to

have both web based and mobile application with user interface and heuristics that look same and flawless.

The project used the icon like design on the web application and maintained the same icons on the mobile application to keep consistency and not lose or confuse the stakeholders. Usability, was the biggest driver on the decision to have a hybrid development of the mobile application to maintain consistency and not confuse stakeholders when they change platforms.

Usability testing was carried out in 14 schools in Nairobi County. 80% percentage rate was registered by students and parents. School administrators registered 60% satisfaction with the system.

The bar chart presented in Figure 5.12 illustrates parents' response to the question: Do you navigate the platform easily via menus.

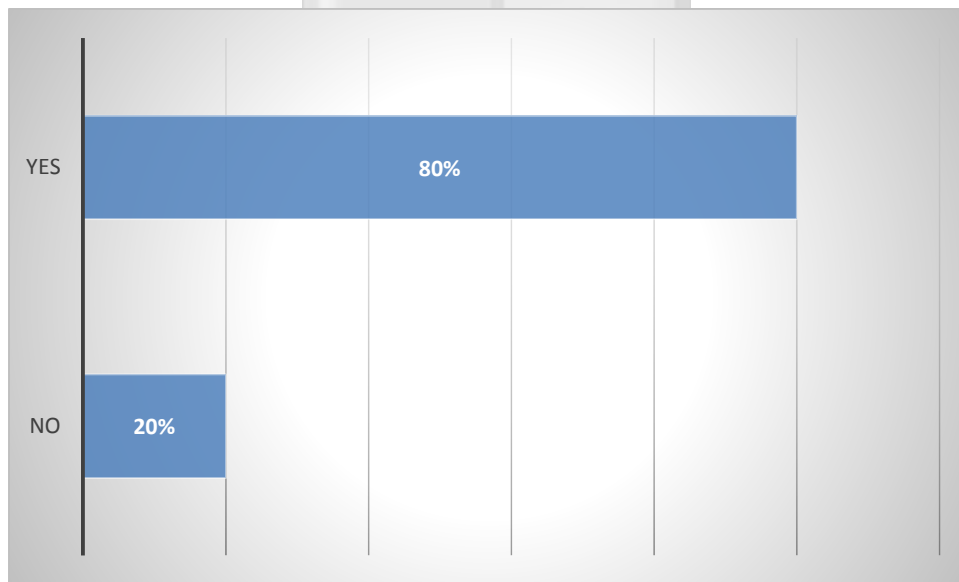


Figure 5.13 : Parents' Usability Feedback

### 5.3.4 Regression Testing

#### 5.3.4.1 Creation of Account

User creates an account by filling the fields on the form illustrated in Figure 5.13.

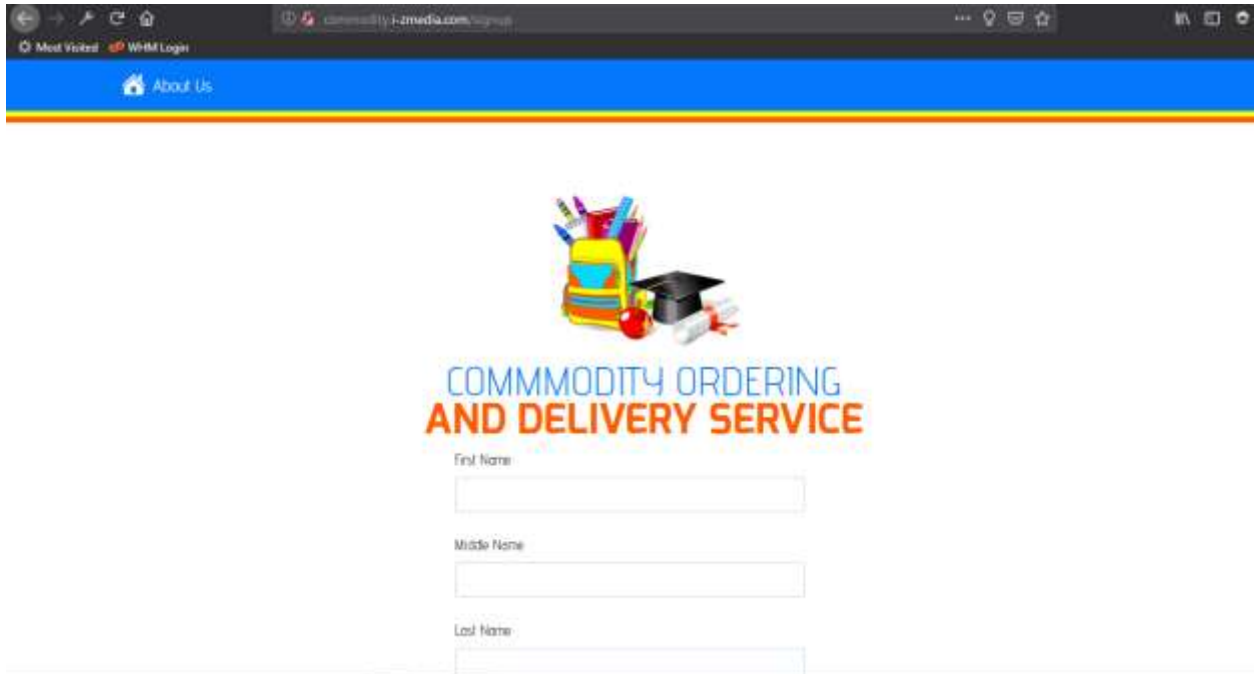


Figure 5.14 : User Sign-Up Page

Once the user has signup successfully, they receives the email on Figure 5.14

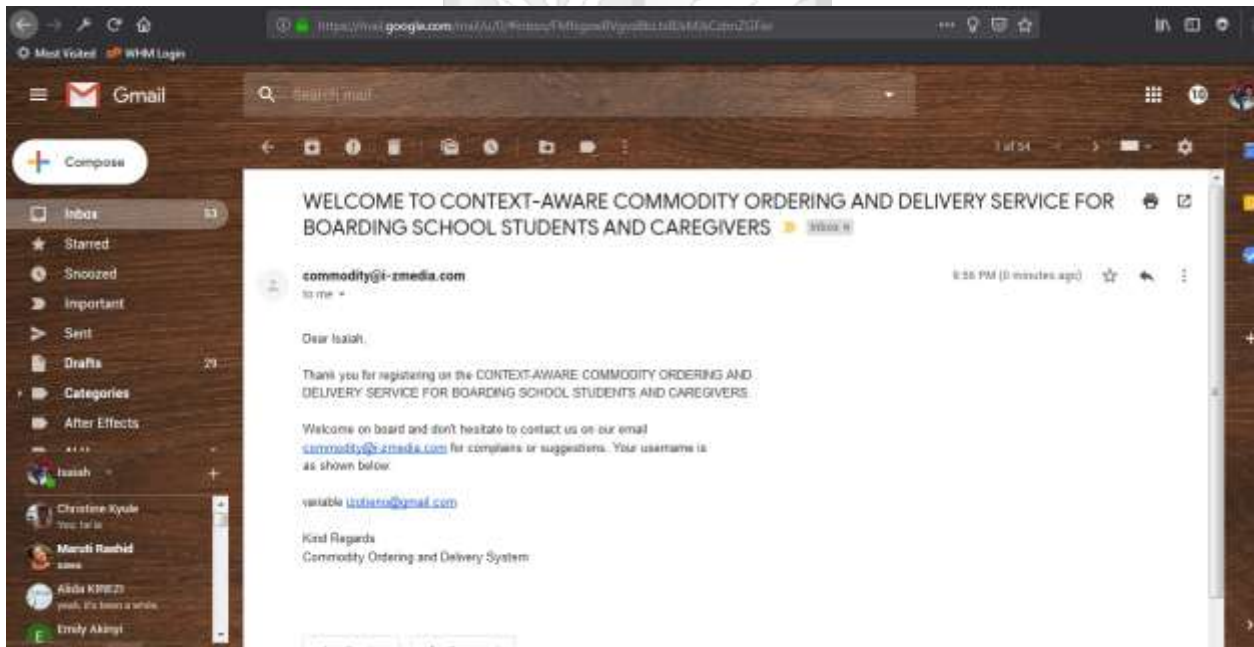


Figure 5.15 : Automatic Registration Email

### 5.3.4.2 Signing in to the System

A user sign in to the system by visiting the page as illustrated in Figure 5.15. They choose the user type and enter their email and passwords to login.



Figure 5.16 : User Sign-in

### 5.3.4.3 Parent Adding a Child

A parent is able to add their children via edit profile menu item. They can add up to 5 children in boarding school as illustrated in Figure 5.16.

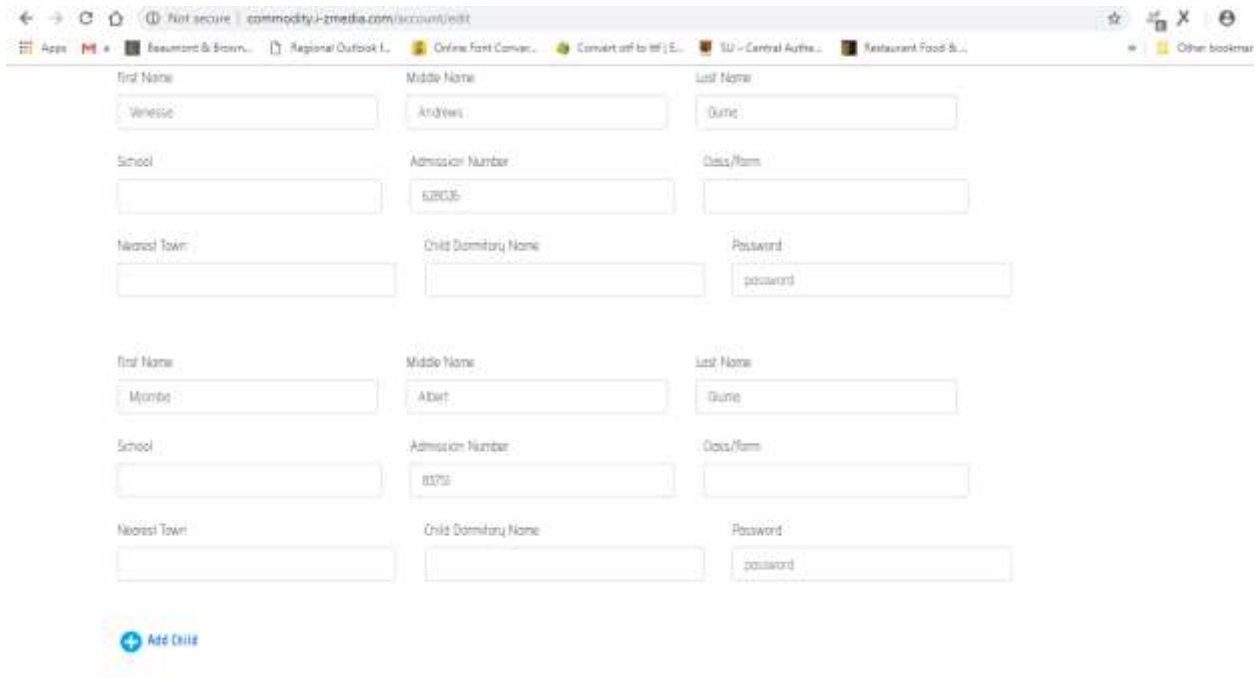


Figure 5.17 : Adding a Child User Interface

### 5.3.4.4 Initiating an Order

A student or parent can initiate a request by choosing the products they need and submitting the request. Figure 5.17 show the interface with a student logged in.

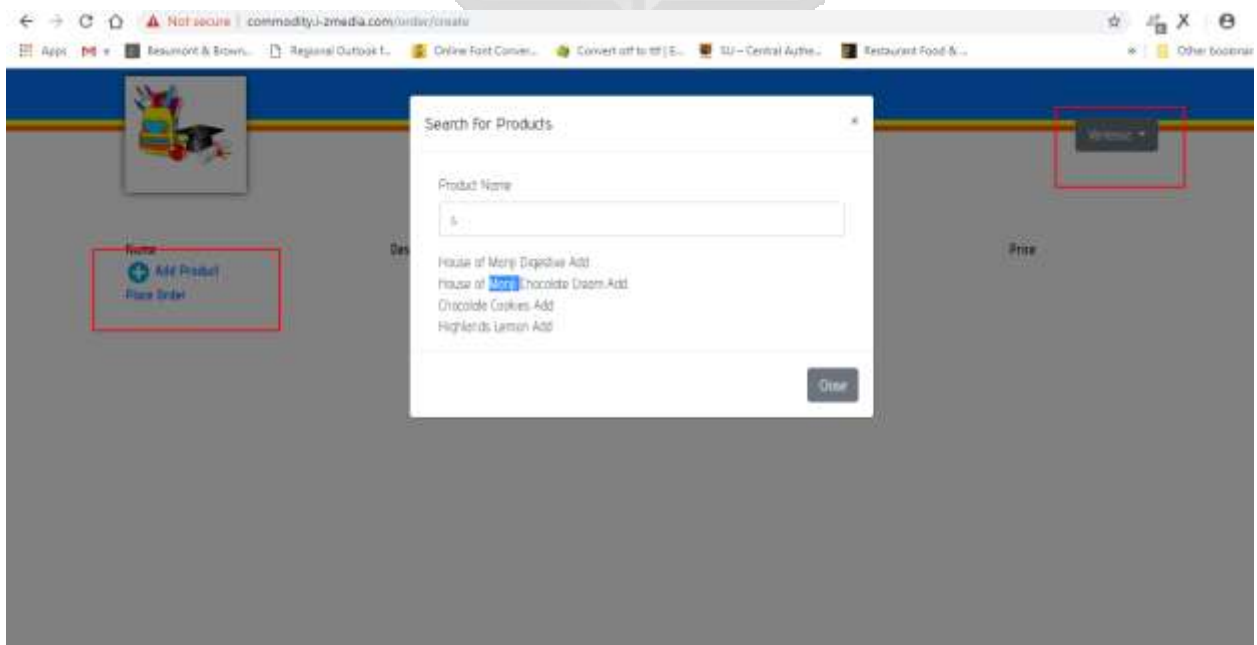


Figure 5.18 : The Interface for Initiating a Request

### 5.3.4.5 Parent Approving an Order

A parent user logs in to approve a request or deny request from a child in boarding school. Figure 5.18 illustrates this web interface.



Figure 5.19 : Parents' Screen Before Confirming an Order

The parent is able to edit the order by removing the line item before making approval. After approval the parent is not able to make any edits. Figure 5.19 illustrates this.



Figure 5.20 : Confirmed Order

### 5.3.5 Compatibility Testing

Compatibility tests were carried out to ensure the developed application was compatible with various platforms where it could be used. The tests results shown on Table 5.7 Show the web version of the application on two main browsers

Table 5.7 : Web Compatibility Test Results

<b>Type of web browser</b>	<b>Compatibility acceptance</b>
Google Chrome version 72 and above	Yes
Mozilla Firefox	Yes

The Project also carried the mobile application compatibility test across the three main platforms; iOS, Android and Windows. Table 5.8 gives the results of the test.

Table 5.8 : Mobile Compatibility Test Results

<b>Type of mobile Operating System</b>	<b>Compatibility acceptance</b>
Android Lollipop and above	Yes
iOS version 11 and above	Yes

## Chapter 6 : Discussion

### 6.1 Introduction

The chapter discusses the data collected; the deeper insight of the data in terms of the strategic position of the system; the main advantage of the location based commodity ordering system and the limitation of the system in the field application.

The chapter also reviews the various objectives of the project and the project attempts at addressing these objectives to finally come up with a location-based commodity ordering and delivery system: case of boarding schools in Nairobi

### 6.2 Findings and Achievements

The interesting finding was that most school administrators were concerned of the school canteen fate if the system is implemented. Some administrators were concerned that the system may lead to social stratification in schools, considering that some students do not have parents who can make such orders for them. However, this line of thinking is debatable as these students are currently in schools and they are using commodities one way or the other. It is safe to therefore summarize that the project got some resistance to administrators who were not ready to embrace change.

However, the project was also able to meet very positive administrative who could see that the system saves parents money and make their lives much more easier. Though most schools have school canteens, the canteens are not stocked with everything that's the students might need like buckets, basins or shoes. If looked from a broader perspective of other needs other than bread and sugar delivery, administrators were able to see the sense though some still with reservations.

Parents and students were more positive and receptive about the system with some even giving suggestions on how to improve the system. One parent who had two children in boarding schools had a challenge of visiting the student as most of the time the visiting days would be on the same day ad since they are single parents, this has proved to be a thorn in her flesh. If she had such a service, she said, this would have solved her problems.

### **6.3 Review of Research Objectives in Relation to the Mobile Application**

The first objective of the project was to investigate the challenges that face commodity ordering and delivery in boarding schools. In chapter two of this document, the project explored the current policies that regulate high school boarding schools in Kenya and whether the policies are enablers of the system or not. In chapter four of the project, the work investigate this further by going to the main stakeholders and seeking their views on the need of this service. Though a large number of the stakeholder are positive about the project, reservations are reported mainly from school administrators, possible because of the fear of set policies from the ministry and/or reluctance in accepting change.

The second object of this work was to analyse current techniques, models and technologies used in location based services. In chapter two of this document, the work delves deeper into technology that enables the system to be location based as much as possible by exploring various context aware angles that needs to be considered. The system was looking at location based services in terms of automatic smart searching of suppliers closest to the school to save parents money, and guiding of the delivery person to the school location by way of google map. The technologies such as geospatial data and google map coordinates influenced the type of database that the system used in the end.

The third objective was to develop a platform that supports ordering and delivering of supplies to students through the power of location based services. Chapter three explored the various software development resources, techniques and designs that would help in developing the system. The blueprint for the development of the system were drawn in this chapter and clear roadmap and direction established. In chapter four, the project established the functional requirements of the system from the feedback that it received from the main stakeholder of the system. The functional requirements further modelled the system as the tools to be used in development are greatly influenced by the needs that the final product have to fulfil.

The final objective was to validate that the developed location based supplies ordering and delivery application so as to confirm that it provides a proper services to student, parents, guardian and school needs. The system was developed as shown in chapter five of this work. Considering that preference for web based application and mobile based application on average across all

stakeholders was 50/50, the project first developed a web based system with strong authentication and processing of the data. An application programming interface (API) was then developed to connect the web application to the mobile application that was developed through Ionic framework. The framework was chosen to enable hybrid development of the mobile application to cover all mobile platforms.

#### **6.4 Advantages of the Application in Contrast with the Current System**

The biggest advantage of this system is the fact that a parent seated at home can solve a problem that is miles away without calling in favour from relatives staying close to the school. The student do not have to interrupt their studies by asking for home leaves to go back home to collect commodities. It eradicates the risk of parent giving the student too much pocket money that can be used on things that the pocket money was not intended for. A parent cannot determine what pocket money will be used for, so instead of giving liquid cash through the bursar, the student gets the commodity they actually need.

#### **6.5 Limitations of the Application**

The greatest limitation of the application is the fact that it needs internet connection to be accessed. As much as internet connection in Kenya has been increasing on a daily basis, schools that are far away from the cities and big towns may be a challenge to service. An alternative is to use mobile provider's internet services but even these come with limitation in some remote areas that even mobile network is a challenge.

## **Chapter 7 : Conclusions, Recommendations and Future Work**

### **7.1 Introduction**

The main objective of this project was to develop a system that would enable students request commodity from school; have parents order these commodities and have the commodities delivered to the school within the shortest time possible to avert any inconvenience to the parent and student and at the most competitive costs available in the market. The system was to look at the closest shop/supplier near to the school and calculate the distance to the school and hence apply the delivery charges accordingly.

The system mission being to solve the inconvenience faced by the middle class parents who sometimes find themselves between a rock and hard place, when they face competing priorities by virtue of student needing a critical commodity urgently in school while the parent is also busy with work and other responsibilities. The functionalities of the system were developed only after interviewing the main stakeholders to find their views on some critical functionalities of the system. The system ensured that no unauthorised product can get into school by providing a feature that enable administrators to ban a product and hence withdraw a product from the list that parents can order. The student identity is kept anonymous by the virtue of the delivery person only dealing with order number hence protecting the student. The school administrators are able to control access of the system by students by being able to define the day the students are allowed to access the system.

### **7.2 Conclusions**

Government and school policies both of which intends to improve the quality of education in our boarding school have impacted the students' lives both positively and negatively. One of the main areas that the policies have really hit is the number of times the parents and students get to see each other. This challenge is magnified by the fact that parent lives is getting busy by each day given that the all parents have to get involved in some form of economic activities to make ends meet.

The platform got insight from the above mentioned challenges and solve the issue by providing a student with a system that enables a student to make request from school at a click of a button. The parent is able to respond to a child problem by pressing button. A supplier is able to sell their commodity at a press of a button without spending a coin in marketing: a win-win for all involved. Large percentage of the parents welcomed the platform with open arms while a noticeable resistance was received from the school administrators. The biggest fear here being the platform rendering the canteen useless and illegal products getting into school. But the fear is based on the rigidity of resisting the unknown; in fact all issue mentioned as challenges are all strengths: The school canteen can register in the portal for instance and when they receive orders of commodity not stocked in the canteen like uniform or clothes, they source from outside partners and deliver to the student hence not losing out.

### **7.3 Recommendations**

The ministry if the education has a department called *partners department* which is tasked with bringing on board technologies, ideas and/or inventions that can add value to the education system if incorporated. The best scenario for the system to be accept to the school would be to have ministry directive to schools to use the system. This can only be achieved via a very strong value preposition to the ministry.

One of the value preposition of the system would be a centralized system where the government can communicate with all parents of boarding school students. In this way, the ministry would save millions in newspaper and television advertisements. This channel can be explored to include two way traffic where parents can give feedback through the system to the government or report some gross misconduct in a school and so on. This will ensure the ministry will have huge database of primary data that will help them in making informed decisions not only at county level but also at national level. The combined result of this will be improved services to the students and thus to the parents. On a click of a button, the ministry will be able to know how many schools are in a given county, data that is current very fragmented, not clear and difficult to locate.

## 7.4 Future Work

Apart from having the benefits already mentioned in this paper, this project would be more beneficial to the stakeholders with the support of the ministry. The below are some areas that the project would have meaningful impact:

- I. Developing the system to have one central communication platform that at a click the government can reach all parents; at one click the government can reach all schools. This will help the government make the much needed savings in advertisement and use those resources elsewhere. The system can be improved to have a mechanism that parents, students and school administrators can give feedback whether anonymously or not. This will result to major data warehouse for the ministry, a valuable resources that if analysed well can give the ministry valuable information that can help them tailor their policies and provide better services to the society.
- II. An API from the Kenya Universities and College Central Placement Services (KUCCPS) would help the integration of the system with the KUCCPS system that will allow the parents and the students to know which institution of higher education have the student been enrolled in. This way the system will be able to propose to the parent the kind of shopping the parent need to make given the course the student have been enrolled on and the location of the institution. KUCCPS on the other hand will pull the contact details of the parents and will not have to wait for the student to create an account to get the contact of the parent. This will enable KUCCPS to save money –the SMS costs; by sending notification of the enrolment process to parents email. They can also update their phone book with the number of the parents such that when the parent calls they will know the name of the parent and the student name who the parent could be enquiring about.

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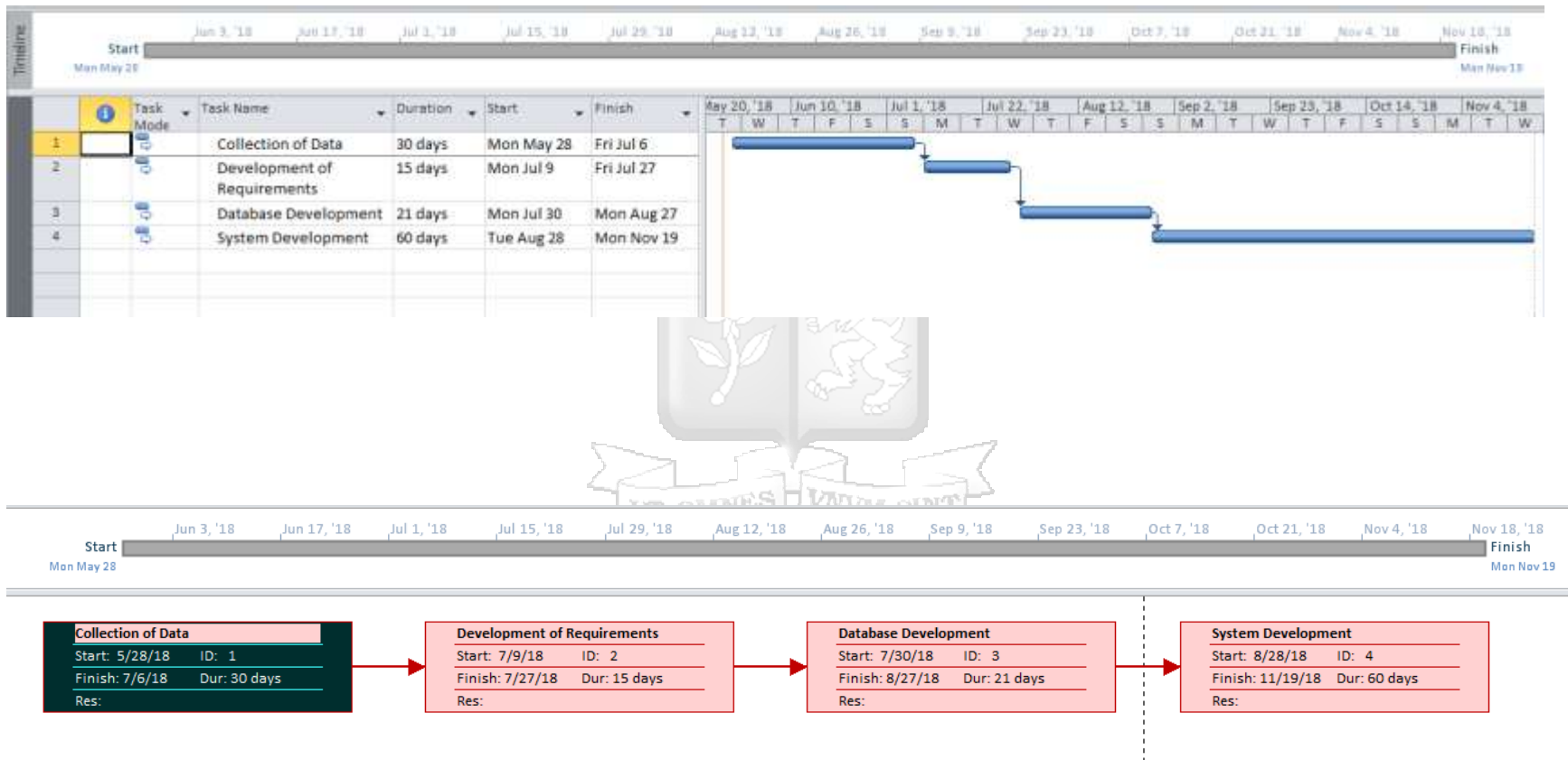
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## APPENDICES

### Appendix A: Time Schedule





## Appendix B: NACOSTI Research Permit

**THIS IS TO CERTIFY THAT:**  
**MR. ISAIAH OUMA OTIENO**  
**of STRATHMORE UNIVERSITY,**  
**30552-100 Nairobi, has been permitted**  
**to conduct research in Nairobi County**


**on the topic: CONTEXT-AWARE**  
**COMMODITY ORDERING AND DELIVERY**  
**SERVICE FOR BOARDING SCHOOL**  
**STUDENTS AND CAREGIVERS: CASE OF**  
**BOARDING SCHOOLS IN NAIROBI**

**for the period ending:**  
**6th August, 2019**

**Permit No : NACOSTI/P/18/65860/24341**  
**Date Of Issue : 7th August, 2018**  
**Fee Recieved :Ksh 1000**



**Applicant's**  
**Signature**



**Director General**  
**National Commission for Science,**  
**Technology & Innovation**

## Appendix C: Turn It In Match Overview

Most Visited WHM Login

feedback studio

Isaiah Otieno Ouma | ISAAH OTIENO THESIS

Match Overview

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2	Submitted to Mount Ke... Student Paper	1%
3	Submitted to Strathmor... Student Paper	1%
4	<a href="http://code.tutsplus.com">code.tutsplus.com</a> Internet Source	1%
5	<a href="http://www.rishabhsoft.com">www.rishabhsoft.com</a> Internet Source	<1%
6	<a href="http://www.interaction-design...">www.interaction-design...</a> Internet Source	<1%
7	<a href="http://www.queppelin.com">www.queppelin.com</a> Internet Source	<1%

By  
ISAAH OUMA OTIENO  
REGISTRATION NUMBER: 083751

23  
A Thesis Submitted to the Faculty of Information in partial fulfillment of the requirements for  
the award of Master of Science in Information Technology of Strathmore University

Page: 1 of 164 | Word Count: 30166 | Text-only Report | High Resolution On

## Appendix D: Turn It In Report

Most Visited WHM Login

Document Viewer

### Turnitin Originality Report

Processed on: 23-Mar-2019 11:29 AM EAT  
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Submitted: 1

ISAAIAH OTIENO THESIS By Isaiah Otieno Ouma

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## **Appendix E: Student Questionnaire**

### **QUESTIONNAIRE FOR BOARDING SCHOOL STUDENTS ON THE CHALLENGES OF COMMODITIES REPLINISHING IN SCHOOLS**

#### **Purpose**

The aim of this study is to develop a platform that will conveniently, efficiently and effectively facilitate the ordering of school supplies by the boarding students, the parents approving these orders and the successful delivery of the orders to the student that initiated the order.

#### **Confidentiality**

The data and/or information collected shall be treated with utmost confidentiality and shall not be shared without your prior permission.

#### **Directions in responding to the Questionnaire:**

1. Please check all boxes that apply in each question.
2. References to “you” or “your” refer to your school or you as an individual.
3. “System” means a web based portal or mobile application that will enable students to make orders; parents to approve these orders or reject them, supermarkets to deliver the approved orders to the student in school and the parent to pay delivered products.
4. “Products” refers to simple supplies and consumable that range from school uniform, beddings, books, food stuff (Juice, cookies, biscuits, pop corns etc.)

#### **Correspondence/Inquiries:**

Mr. Isaiah Otieno (Isaiah.otieno@strathmore.edu)

UNEP, Civil Society Unit, Governance Affairs Office,

P.O. Box 30552 - 00100, Nairobi.

Skype: isaiah.otieno2012

Tel: +254-2076-24786

Mobile Number(s): +254 (0) 737403969

1. Age: \_\_\_\_\_

2. Gender:

Male

Female

3. Place of residence: County/City:

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4. What school do you go to? (Please state the name of your school):

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5. Location of school (Country/City):

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6. Is your school a state school or a private institution?

State Schools

Private Institutions

7. Which form are you in: \_\_\_\_\_

8. Do you have midterm break in your school? \_\_\_\_\_

9. How many times do you get to see your parent(s) in a single term?

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10. Are there rules on the edible products that are allowed in school?

Yes

No

11. If YES, please list products that are not allowed in school.

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12. Is home leave allowed in your school? \_

- Yes
- No

13. Have you ever been “stuck” in school because your parent could not get to you a personal effect or commodity in time?

- Yes
- No

14. Do you think you need a commodity delivery system for ordering personal effects and/or replenishing your supplies to you in school?

- Yes
- No

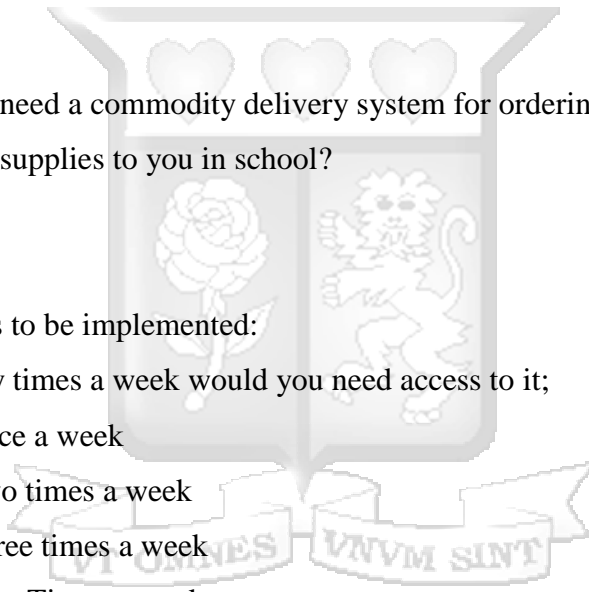
15. If such a system is to be implemented:

a. how many times a week would you need access to it;

- Once a week
- Two times a week
- Three times a week
- Four Times a week
- Every day of the week

b. On which day(s) would you want to access the system?

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday



16. If such a system is to be implemented, which of the following options would you prefer as a login mechanism for you to login to the system?

- Student number and Password
- Student Biometric
- Student special PIN

17. Who would you recommend to collect the delivery of the product:

- Student
- Teacher on duty
- Bursar
- Other(Please Type)

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18. At what point would you like confirmation of the products delivery to be made to your parent:

- When you receive the commodities
- When the teacher on duty receives the products

- THANK YOU -

## **Appendix F: School Administrators Questionnaire**

### **QUESTIONNAIRE FOR BOARDING SCHOOL ADMINISTRATORS ON THE CHALLENGES OF COMMODITIES REPLINISHING IN SCHOOLS**

#### **Purpose**

The aim of this study is to develop a platform that will conveniently, efficiently and effectively facilitate the ordering of school supplies by the boarding students, the parents approving these orders and the successful delivery of the orders to the student that initiated the order.

#### **Confidentiality**

The data and/or information collected shall be treated with utmost confidentiality and shall not be shared without your prior permission.

#### **Directions in responding to the Questionnaire:**

5. Please check all boxes that apply in each question.
6. References to “you” or “your” refer to your school or you as an individual.
7. “System” means a web based portal or mobile application that will enable students to make orders; parents to approve these orders or reject them, supermarkets to deliver the approved orders to the student in school and the parent to pay delivered products.
8. “Products” refers to simple supplies and consumable that range from school uniform, beddings, books, food stuff (Juice, cookies, biscuits, pop corns etc.)

#### **Correspondence/Inquiries:**

Mr. Isaiah Otieno (Isaiah.otieno@strathmore.edu)  
UNEP, Civil Society Unit, Governance Affairs Office,  
P.O. Box 30552 - 00100, Nairobi.  
Skype: isaiah.otieno2012  
Tel: +254-2076-24786  
Mobile Number(s): +254 (0) 737403969

1. Position/Job title in School:

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2. Please state the name of your school:

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3. Location of school (Country/City):

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4. Is your school a state school or a private institution?

- State Schools
- Private Institutions

5. Do you have midterm break?

- Yes
- No

6. How many events per term in school involves parents coming to school?

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7. Are there rules on the edible products that are allowed in school?

- Yes
- No

8. If YES for question 7, please list products that are not allowed in school.

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9. Is home leave allowed in your school?

Yes

No

10. Do the school allow student interaction with the outside world i.e. none faculty and none teaching staff individuals?

Yes

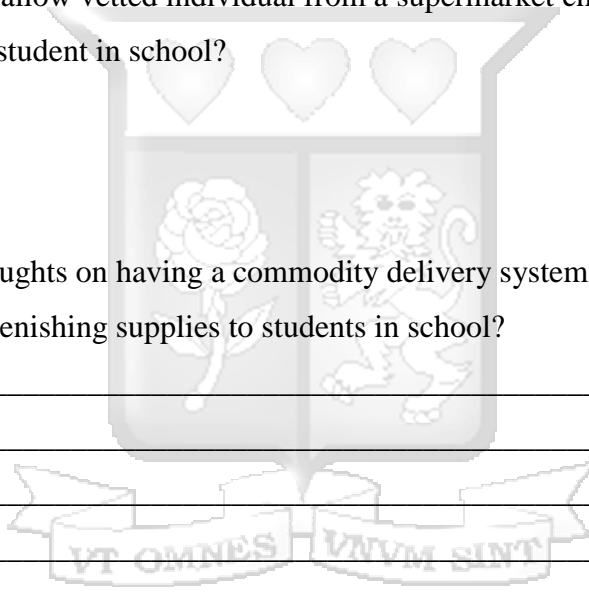
No

11. Would the school allow vetted individual from a supermarket chain to deliver commodities to a student in school?

Yes

No

12. What are your thoughts on having a commodity delivery system for ordering personal effects and/or replenishing supplies to students in school?



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13. If you were to have such a system in school, who would you allow to access it:

Student

Teachers/Staff

14. If students are allowed to access the System in question 13;

a. how many times a week would you allow students access to it;

Once a week

Two times a week

- Three times a week
- Four Times a week
- Every day of the week

b. On which day(s) would you grant access to students to use the system?

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday

15. If such a system is to be implemented, how would the school like to interact with such a system?

- Website
- Phone App

16. Who would you recommend to collect the delivery of the product:

- Student
- Teacher on duty
- Bursar
- Other(Please Type)

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17. Would your school like to inspect the delivery before it is made to the student or would you trust the supermarket delivery?

- Yes
- No

- THANK YOU -

## **Appendix G: Parents Questionnaire**

### **QUESTIONNAIRE FOR PARENTS WITH BOARDING SCHOOL STUDENTS ON THE CHALLENGES OF COMMODITIES REPLINISHMENT IN SCHOOLS**

#### **Purpose**

The aim of this study is to develop a platform that will conveniently, efficiently and effectively facilitate the ordering of school supplies by the boarding students, the parents approving these orders and the successful delivery of the orders to the student that initiated the order.

#### **Confidentiality**

The data and/or information collected shall be treated with utmost confidentiality and shall not be shared without your prior permission.

#### **Directions in responding to the Questionnaire:**

9. Please check all boxes that apply in each question.
10. References to “you” or “your” refer to your school or you as an individual.
11. “System” means a web based portal or mobile application that will enable students to make orders; parents to approve these orders or reject them, supermarkets to deliver the approved orders to the student in school and the parent to pay delivered products.
12. “Products” refers to simple supplies and consumable that range from school uniform, beddings, books, food stuff (Juice, cookies, biscuits, pop corns etc.)

#### **Correspondence/Inquiries:**

Mr. Isaiah Otieno (Isaiah.otieno@strathmore.edu)

UNEP, Civil Society Unit, Governance Affairs Office,

P.O. Box 30552 - 00100, Nairobi

Skype: isaiah.otieno2012

Tel: +254-2076-24786

Mobile Number(s): +254 (0) 737403969

1. How many children do you have in boarding schools:

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2. How many of the children in boarding are in high schools:

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3. Please write the names of:

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4. Location of school(s) (Country/City):

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5. Are the schools a state schools or private institutions?

- State Schools
- Private Institutions

6. Which form are your children in?

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7. Do all the schools have midterm break?

- Yes
- No

8. How many times do you get to see your children in a single term:

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9. Is your child allergic to certain food items?

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10. If yes, kindly list the items they are allergic to

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11. Is home leave allowed in their school(s)?

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12. Have you ever been stuck in delivering a personal effect or a commodity to your child in school due to time constraints or distance to the school?

- Yes
- No

13. Do you think you need a commodity delivery system for ordering personal effects and/or replenishing your supplies to you in school?

- Yes
- No

14. If you were to have such a system in school, how would you want to make the payment done?

- after delivery
- before delivery

15. Who would you like to make confirmation of the products:

- Your child
- Teacher on duty
- Bursar
- Others

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## Appendix H: Data Collection Reference Letter from Supervisor



9<sup>th</sup> July 2018

Dear Sir/Madam,

RE: INTRODUCING ISAIAH OUMA OTIENO, MASTERS STUDENT AT STRATHMORE UNIVERSITY

Mr. Isaiah Ouma Otieno, student number 83751, is a student at Strathmore University pursuing a Master's degree in Information Technology. Isaiah has completed his coursework and is now working on his Thesis paper/project to fulfill his requirements to graduate in June 2019. On his topic of choice title "CONTEXT-AWARE COMMODITY ORDERING AND DELIVERY SERVICE FOR BOARDING SCHOOL STUDENTS AND CAREGIVERS: CASE OF BOARDING SCHOOLS IN NAIROBI", Isaiah is required to interview fourteen boarding school principle/administrators in Nairobi county to collect data that will inform his study.

As such, we would like to kindly request for your time of 20 minutes or less to take a short interview that will help Isaiah greatly in fulfilling his course requirement. As his Thesis supervisor, do not hesitate to contact me via [bshibwabo@strathmore.edu](mailto:bshibwabo@strathmore.edu) for any clarification or more information. Thank you in advance.

Sincerely,

Dr. Bernard Shibwabo  
Director, Research & Postgraduate Studies  
Faculty of Information Technology,  
Strathmore University  
[bshibwabo@strathmore.edu](mailto:bshibwabo@strathmore.edu)

Ole Sangale Rd, Madaraka Estate, PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000  
Email [info@strathmore.edu](mailto:info@strathmore.edu) [www.strathmore.edu](http://www.strathmore.edu)

## Appendix I: NACOSTI Research Authorization Letter



### NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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When replying please quote

NACOSTI, Upper Kabete  
Off Waiyaki Way  
P.O. Box 30623-00100  
NAIROBI-KENYA

Ref. No. **NACOSTI/P/18/65860/24341**

Date: **7<sup>th</sup> August, 2018**


Isaiah Ouma Otieno  
Strathmore University  
P.O. Box 59857, 00200  
**NAIROBI.**

#### **RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on "*Context-aware commodity ordering and delivery service for boarding school students and caregivers: Case of boarding schools in Nairobi*" I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **6<sup>th</sup> August, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

  
**DR. STEPHEN K. KIBIRU, PhD.**  
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner  
Nairobi County.

The County Director of Education  
Nairobi County.

