



Electronic Theses and Dissertations

2019

A Mobile application that enables restaurants list their left-over food at discounted rates in Nairobi

Bettirose Njoki Ngugi
Faculty of Information Technology
Strathmore University



Follow this and additional works at <https://su-plus.strathmore.edu/handle/11071/6758>

Recommended Citation

Ngugi, B. N. (2019). *A Mobile application that enables restaurants list their left-over food at discounted rates in Nairobi* [Thesis, Strathmore University]. <http://su-plus.strathmore.edu/handle/11071/6758>

**A MOBILE APPLICATION THAT ENABLES RESTAURANTS LIST THEIR
LEFT-OVER FOOD AT DISCOUNTED RATES IN NAIROBI**

BETTIROSE NJOKI NGUGI

A dissertation submitted in partial fulfillment of the requirements for the

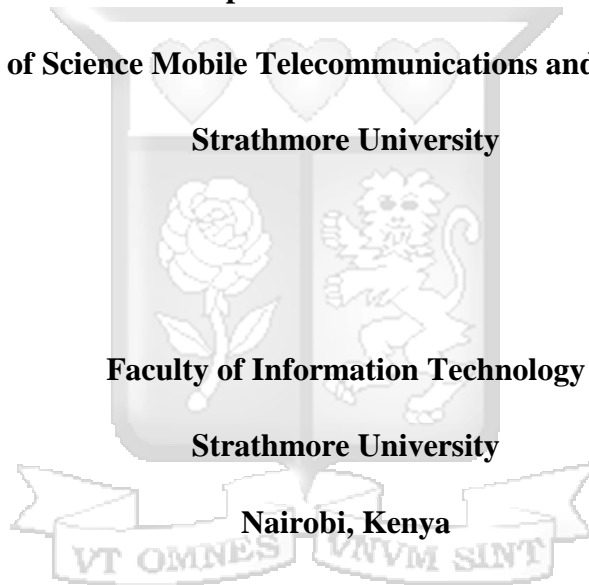
Master of Science Mobile Telecommunications and Innovation at

Strathmore University

Faculty of Information Technology

Strathmore University

Nairobi, Kenya



June 2019


This dissertation is available for Library use on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself. No part of this thesis may be reproduced without the permission of the author and Strathmore University

Bettirose Njoki Ngugi

Student No: 091460

Signature: 

Date: 8th June 2019

Approval

The dissertation of Bettirose Ngugi was reviewed and approved by the following:

Dr. Bernard Shibwabo

Senior Lecturer - Faculty of Information Technology

Strathmore University

Dr. Joseph Orero

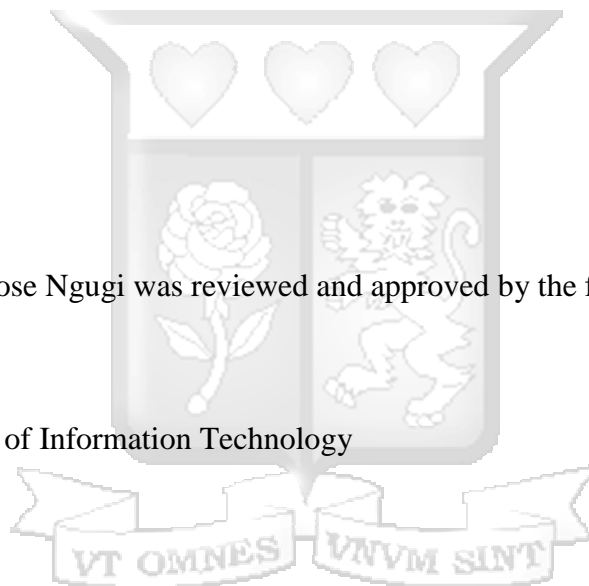
Dean Faculty of Information Technology

Strathmore University

Dr. Ruth Kiraka

Dean, School of Graduate Study

Strathmore University



Dedication

I dedicate this research to my loving parents who have diligently raised me and given me an opportunity to attend school up to this level, to my two lovely brothers Tom and Jose, who continually motivate me to be a better sister and role model and to two beautiful women who ardently pray and inspire me every day to be a strong woman just like them, Pauline Waceke Githaka – my maternal grandmother – and Beth Njoki Muraya – my paternal grandmother.



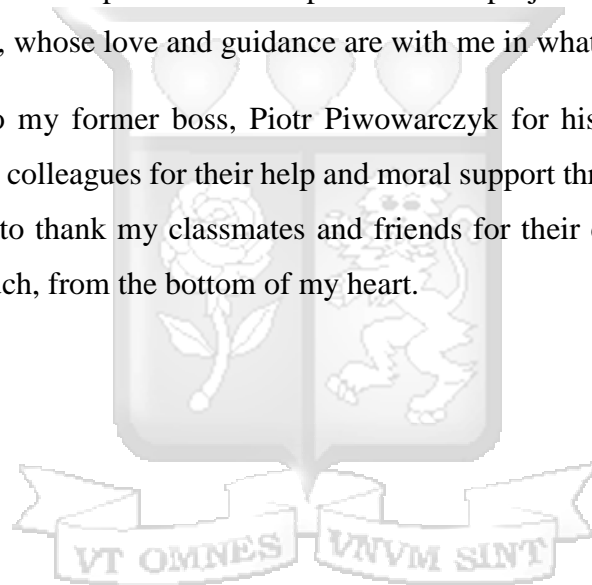
Acknowledgements

This research would not have been successful without the grace of God which has been sufficient every moment of the journey. I am privileged to work with Dr. Bernard Shibwabo as my supervisor, his constant feedback and insight made the learning process while doing this research smooth and fulfilling.

Many thanks to Safaricom Foundation for the partial scholarship to undertake this prestigious program. Without them, I wouldn't have had the opportunity to hone my skills to enable me to impact the world positively through technology.

Nobody has been more important to me in pursuit of this project than my supportive family, mom, dad, Tom and Jose, whose love and guidance are with me in whatever I pursue.

Really grateful to my former boss, Piotr Piwowarczyk for his support while I juggled school with work and my colleagues for their help and moral support throughout the process. Last but not the least, I wish to thank my classmates and friends for their constant support and best wishes. Thank you so much, from the bottom of my heart.



List of Abbreviations and Acronyms

API	-	Application programming interface
ARA	-	Activities, Resources, and Actors
CSS	-	Cascading Style Sheets
ERD	-	Entity Relationship Diagram
ADT	-	Android Development Tools
FAO	-	Food and Agriculture Organization
GPS	-	Global Positioning System
HTML	-	Hypertext Markup Language
HTTP	-	Hypertext Transfer Protocol
KAHKC	-	Kenya Association of Hotel Keepers and Caterers
MWRRG	-	Metropolitan Waste and Resource Recovery Group
OS	-	Operating Systems
PHP	-	Hypertext Preprocessor
REST	-	Representational state transfer
SCM	-	Supply chain management
SDK	-	Software Development Kit
UML	-	Unified Modelling Language
URL	-	Uniform Resource Locator
USA	-	United States of America (USA)

Abstract

Food waste is a huge problem in Kenya and many other countries, in fact, the severity of the problem borders that of climate change and global warming. Institutions in the catering industry such as hotels, restaurants, supermarkets and events caterers prepare food every day that is not all consumed at the end of the day. This is food that is good for human consumption ends up as waste most times. More to this, most consumers make food orders but end up having leftovers on their plates at the end of their meals. Plate waste and vegetable peeling produced during food preparation process is still consumable by animals such as pigs and dogs, but most times than not, ends up in waste bins rotting. While this amount of food goes to waste, more and more people sleep everyday hungry and even more are said not to have a nutritious food to keep them active and healthy. Food waste contributes to global warming through greenhouse gas emission comparable to that produced from road transport and mitigating it will have a positive impact on climate change. This being the case, there is need to bridge the gap between excess food produced by hospitality institutions and those who need it either for their consumption for human consumable food or animal consumption for left-over food. This study seeks to help manage food waste in the hospitality industry, by creating a platform where hotels, restaurants, supermarkets or just companies in the catering business report excess food and people in need of food sign up and place their orders for both human consumable food and plate waste suitable for animals. The organizations have a choice either give up the food for free or charge a small fee. The study provides data to these organization to help perform predictive analysis on trends with a goal of enabling them know how much is consumed and keep this in mind when preparing food to avoid food wastage. The software methodology used is prototyping model. From research, it was established that in deed food waste is a global problem that needs attention and a mobile application was created as the front end interface that allows users to browse through meals and place orders and a backend that allows restaurants to update the mobile application with meals available for the day.

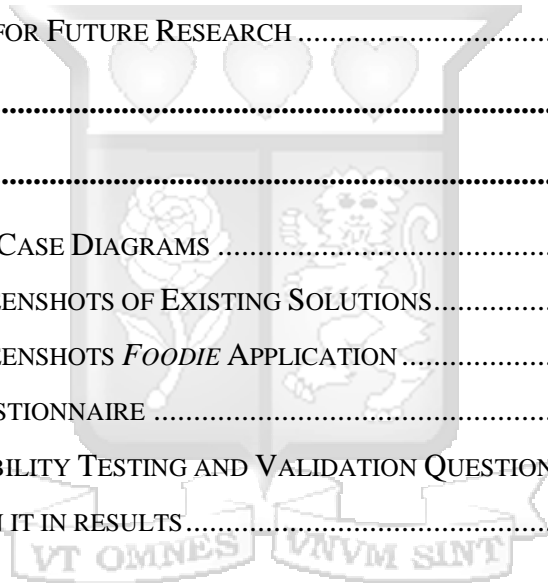
Keywords: Food waste, hospitality industry, predictive analysis, food waste reduction, Foodie.

Table of Contents

CHAPTER 1 : INTRODUCTION.....	1
1.1 BACKGROUND OF THE STUDY	1
1.2 PROBLEM STATEMENT	2
1.3 RESEARCH OBJECTIVES.....	3
1.4 RESEARCH QUESTIONS.....	3
1.5 SIGNIFICANCE OF THE STUDY.....	3
1.6 SCOPE AND LIMITATIONS	4
1.7 CONCLUSIONS	4
CHAPTER 2 : LITERATURE REVIEW	5
2.1 INTRODUCTION	5
2.2 STAGES AT WHICH FOOD WASTE OCCURS	5
2.3 FOOD WASTE IN THE HOSPITALITY INDUSTRY	7
2.4 CAUSES OF FOOD WASTE GENERATION IN HOUSEHOLDS	8
2.5 SUPPLY CHAIN MANAGEMENT.....	9
2.6 THE ARA MODEL	10
2.6.1 <i>Activity Layer</i>	10
2.6.2 <i>Resources Layer</i>	11
2.6.3 <i>Actor Layer</i>	12
2.6.4 <i>Approaches to Food Waste Reduction</i>	12
2.7 EXISTING SOLUTIONS.....	13
2.7.1 <i>Rescuing Leftover Cuisine</i>	13
2.7.2 <i>Saving Grace Initiative in Abu Dhabi (UAE)</i>	14
2.7.3 <i>Food Panda</i>	14
2.7.4 <i>Jumia Food</i>	15
2.8 GAPS AND LIMITATION ON EXISTING TECHNOLOGY	15
2.9 CONCLUSION.....	15
CHAPTER 3 : RESEARCH METHODOLOGY	17
3.1. INTRODUCTION	17

3.2. SOFTWARE METHODOLOGY	17
3.2.1 Planning Phase	17
3.2.2 Requirements Elicitation.....	17
3.3 SYSTEM ANALYSIS AND DESIGN METHODS	18
3.4 APPLICATION IMPLEMENTATION	18
3.5 APPLICATION EVALUATION AND TESTING	19
CHAPTER 4 : SYSTEM DESIGN AND ARCHITECTURE.....	20
4.1 INTRODUCTION	20
4.2 SYSTEM DESIGN.....	21
4.2.1 Data Flow Diagram.....	21
4.2.2 Use Case Diagram.....	22
4.2.3 Sequence Diagram.....	25
4.2.4 Entity Relationship Diagram	25
4.3 SYSTEM ARCHITECTURE	27
4.3.1 Three Tier Architecture.....	27
4.4 SYSTEM REQUIREMENTS	20
4.4.1 Functional requirements.....	20
4.4.2 Non-functional Requirements	21
CHAPTER 5 : PROTOTYPE BUILDING AND TESTING.....	29
5.1 INTRODUCTION	29
5.2 IMPLEMENTATION ENVIRONMENT.....	30
5.2.1 Hardware Environment	30
5.2.2 Software Environment.....	30
5.3 SYSTEM IMPLEMENTATION	30
5.3.1 Mobile Application.....	31
5.4 SYSTEM TESTING	33
5.4.1 Functional Testing	33
5.4.2 Usability Testing	36
5.4.3 Compatibility Testing.....	39
5.5 SYSTEM EVALUATION AND VALIDATION	40

5.6 SUMMARY	40
CHAPTER 6 : DISCUSSIONS	41
6.1 INTRODUCTION	41
6.2 DISCUSSION IN RELATION TO RESEARCH OBJECTIVES	41
6.3 ADVANTAGES OF THE APPLICATION AS COMPARED TO THE CURRENT SYSTEM.....	42
6.4 LIMITATION OF THE APPLICATION.....	43
CHAPTER 7 : CONCLUSIONS	44
7.1 CONCLUSIONS	44
7.2 RECOMMENDATIONS	44
7.3 SUGGESTIONS FOR FUTURE RESEARCH	45
REFERENCES.....	47
APPENDICES	51
APPENDIX A: USE CASE DIAGRAMS	51
APPENDIX B: SCREENSHOTS OF EXISTING SOLUTIONS.....	54
APPENDIX C: SCREENSHOTS <i>FOODIE</i> APPLICATION	56
APPENDIX D: QUESTIONNAIRE	60
APPENDIX E: USABILITY TESTING AND VALIDATION QUESTIONNAIRE.....	63
APPENDIX F: TURN IT IN RESULTS.....	65

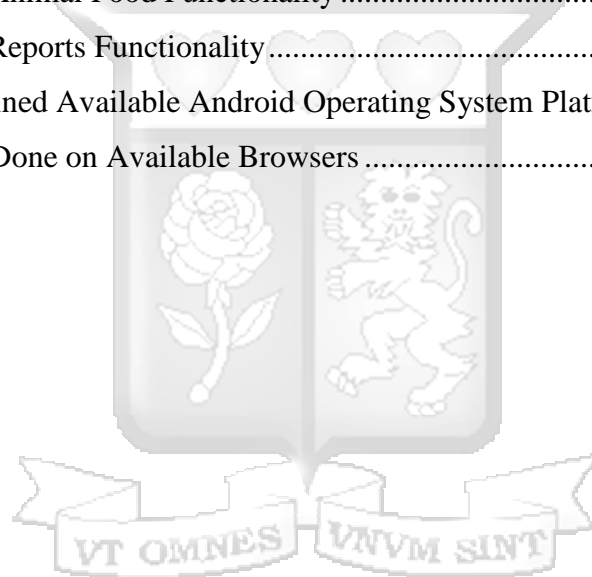


List of Figures

Figure 2.1: Stages of Food Wastage	6
Figure 2.2: Comparison between Food Waste in Developing and Developed Countries	6
Figure 2.3: Materials Flow Analysis for a Lunch Buffet at a UAE Hotel	7
Figure 2.4: MFA Results for a Lunch Buffet Vs. a Wedding Buffet at UAE Hotels	8
Figure 3.1: Prototyping Model.....	17
Figure 4.1: Context Diagram	22
Figure 4.2: Level 1 Data Flow Diagram	22
Figure 4.3: Use Case Diagram	24
Figure 4.4: Sequence Diagram for the Solution.....	25
Figure 4.5: Entity Relationship Diagram	26
Figure 4.6: Three-tier Architecture	28
Figure 5.1: View Restaurants and Meals	32
Figure 5.2: Add to Cart Screenshot.....	32
Figure 5.3: Orders and Making Payment.....	33
Figure 5.4: User Friendliness Testing.....	37
Figure 5.5: System Functionality Acceptance Testing	37
Figure 5.6: Acceptability	38
Figure 5.7: User Interface Aesthetics.....	39
Figure 5.8: Evaluation and Validation of the Solution	40

List of Tables

Table 4.1: Login/Logout Use case Description	23
Table 4.2: Upload Meals Use Case Table.....	24
Table 5.1: Add Restaurant Functionality	34
Table 5.2: Add Meal Functionality.....	34
Table 5.3: View Restaurant Functionality	34
Table 5.4: View Meals Functionality.....	34
Table 5.5: Add Meal to Cart Functionality.....	35
Table 5.6: Checkout Functionality.....	35
Table 5.7: View Animal Food Functionality	35
Table 5.8: View Reports Functionality.....	36
Table 5.9: Predefined Available Android Operating System Platforms.....	39
Table 5.10: Test Done on Available Browsers	40



Chapter 1 : Introduction

1.1 Background of the Study

Food and Agriculture Organization (FAO) defines food waste as food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil (FAO, 2013). There are many reasons why food goes to waste for example oversupply in the market or bad consumer eating habits. Every year, one third of food produced globally for human consumption goes to waste amounting to loss of approximately \$680 billion in developed countries and \$310 billion in developing countries (FAO, 2013).

Interestingly, food wasted in Africa can comfortably feed 300 million people (FAO, 2013). Approximately 870 Million people globally do not eat enough to be healthy and one in eight people go to bed hungry every day (Stop Wasting Food Movement, 2019). This clearly shows that there is a gap between people who have surplus food and those in need of it.

There are pressing impacts of climate change, food insecurity and oil in the twenty-first century and food wastage seems like it will join the list too soon (Munro, Miroso, Mangan-Walker, & Pearson, 2016). One fifth of food delivered to hospitality institutions is lost as research shows (Engstrom & Carlsson-Kanyama, 2015) and this food is wasted in two major ways. The first one is when edible food is thrown away (Principato, Secondi, & Pratesi, 2015) and the second way is through food waste during food preparation stage where there are such things as peelings (Principato et al., 2015). Edible food is thrown away either because it was served and left on plates or it was cooked and no one ordered it and therefore may go stale and get thrown away.

Recently, France became the first country to ban supermarkets from throwing or destroying unsold food and instead forced them to donate the food to charity and to the needy (Chrisafis, 2016). This clearly shows that even supermarkets significantly contribute to food waste since they stock edibles such as bread, drinks and groceries. With France requiring all supermarkets to make donations to the homeless and less privileged, we could well be on the right direction in managing the food waste problem.

The effects of food waste are dire, for example the energy that goes into the production, harvesting, transporting, and packaging of that wasted food generates more than 3.3 billion metric tons of carbon dioxide (UN Environment, 2019). If food waste were a country, it would be the

world's third largest emitter of greenhouse gases, behind the United States of America (USA) and China (UN Environment, 2019). This study is going to look into this gap by analyzing the problems in the hospitality industry as regards to food wastage and propose a solution to ensure this surplus supply of food gets to those in need instead of going to waste.

There are about 9,450 registered caterers and hotels according to the Kenya Association of Hotel Keepers and Caterers (KAHC) an organization that brings together hotels, lodges, restaurants, membership clubs and prominent airline caterers in Kenya (Kenya Association of Hotel-Keepers and Caterers, 2019). These are institutions that are directly involved in preparation of food for human consumption and usually, this process leads to wastage in form of fruit and vegetables offcuts such as peelings, spoilt or contaminated raw materials, leftovers from served meals and unserved residual prepared meals every day.

According to a research conducted by Metropolitan Waste and Resource Recovery Group in Melbourne (MWRG), total waste volumes generated by hospitality institutions averages between 1500-2000 tons per annum (Resource Efficient Scotland; Natural Scotland; Catering Equipment Suppliers Association, 2012). The situation is worse in UK where there is 79000 tons of food wasted every year and 68M tons in United States of America (Resource Efficient Scotland; Natural Scotland; Catering Equipment Suppliers Association, 2012).

1.2 Problem Statement

Food waste is a global problem and it takes place at every stage of the supply chain with institutions in the hospitality industry such as restaurants, supermarkets being participants in the problem. According to (Kasim, 2007), food wastage accounts for 46% of all waste produced by Kenyan hotels. In addition to these statistics, 42 million people in the world do not have enough to eat (FAO, 2019). Every day, restaurants prepare food expecting customers to come and indulge but rarely is all the food prepared consumed. Most of the times, the restaurants refrigerate it and sell the food to the first customers the next day, however, this is unethical since restaurants are expected to only sell freshly prepared food. This poses a problem to the restaurants on what to do with excess food in their kitchen at the end of the day, and this problem contributes to the food wastage problem globally. These statistics clearly shows that there is need to better manage this waste or even better, reduce it and this study is going to propose a solution to better manage this problem.

1.3 Research Objectives

- i. To investigate challenges in the hospitality industry with regards to food wastage.
- ii. To review the existing food applications in the hospitality industry.
- iii. To develop and test a system that helps manage the food wastage problem in the hospitality industry.
- iv. To validate the system to ensure it solves the food wastage problem.

1.4 Research Questions

- i. What are the challenges in the hospitality industry with regards to food wastage?
- ii. How have the existing food applications been implemented?
- iii. How can the proposed mobile application be developed and tested?
- iv. How can the developed mobile application be validated?

1.5 Significance of the Study

During his inauguration speech for his second term in office, President Kenyatta, named food security as one of the key pillars his government will focus on in the next five years. While his focus to solve the problem majored in creating an environment where farmers are not entirely dependent on rainfall to grow food, there is a significant implication of food waste in making a country food secure. There is need to ensure that the food produced by farmers ends up in citizen's plates and not in litter bin as waste food. According to Leopold, 1.3 tons of food produced globally goes to waste before getting to the market, this is tantamount to a third of all food produced (Obi, 2017).

Clearly, food waste is a global problem that needs to be addressed and given same attention as climate change since the repercussions are similar. There is need to better manage food wastage by institutions in the hospitality industry and this study designs a solution that addresses this problem. The better we can manage the value chain, the better we are able to budget for food as country.

The main beneficiaries of this research are the hospitality industry institutions such as restaurants, hotels, airlines, supermarkets and caterers since the platform gives them an alternative revenue generating channel while helping them solve the food waste problem they experience every day.

1.6 Scope and Limitations

The solution only targets Nairobi, Kenya since the study focuses on the area. More to that, the solution is a mobile application running on Android platform with a web backend system to be used for analysis and order/meals tracking and processing. The application offers a platform where restaurants and institutions in the hospitality industry can advertise their excess food.

1.7 Conclusions

The chapter has discussed the background of the research highlighting the existing food waste problem. The research aims at developing a mobile application to address the research objectives and respond to the research question. The next chapter, is the literature review.



Chapter 2 : Literature Review

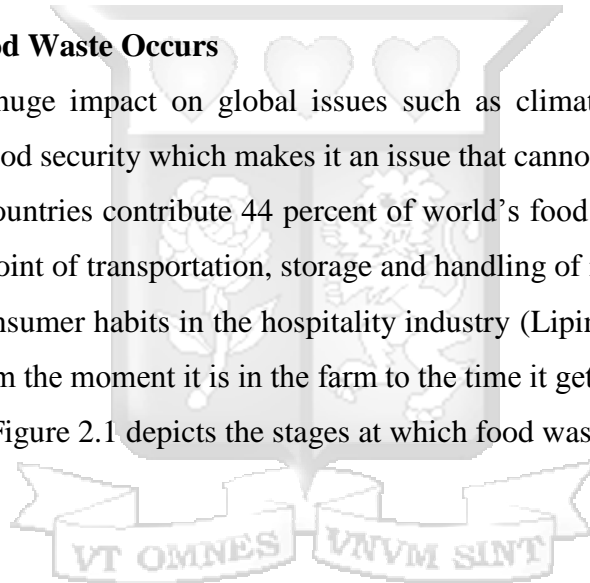
2.1 Introduction

Food waste can be assessed from different angles, this study looks at it from the point at which food gets to the consumer. Specifically, the study delves into the role and contributions of institutions in the hospitality industry in food wastage while reviewing what measures that have been put in place to solve the problem and the gaps that exist at the moment.

In this chapter, the study identifies challenges in the hospitality industry with regards to food wastage then review architectures of food applications already in use in the industry. The conclusion finds a gap in the industry that this study fills.

2.2 Stages at Which Food Waste Occurs

Food waste has huge impact on global issues such as climate change, environmental sustainability and even food security which makes it an issue that cannot be ignored (Block, et al., 2016). The developing countries contribute 44 percent of world's food waste and while much of this waste occurs at the point of transportation, storage and handling of it, there is still a huge part of it that is caused by consumer habits in the hospitality industry (Lipinski, et al., 2013). Food is wasted at every stage from the moment it is in the farm to the time it gets to the consumer's waste bin (Block et al., 2016). Figure 2.1 depicts the stages at which food waste occurs clearly.



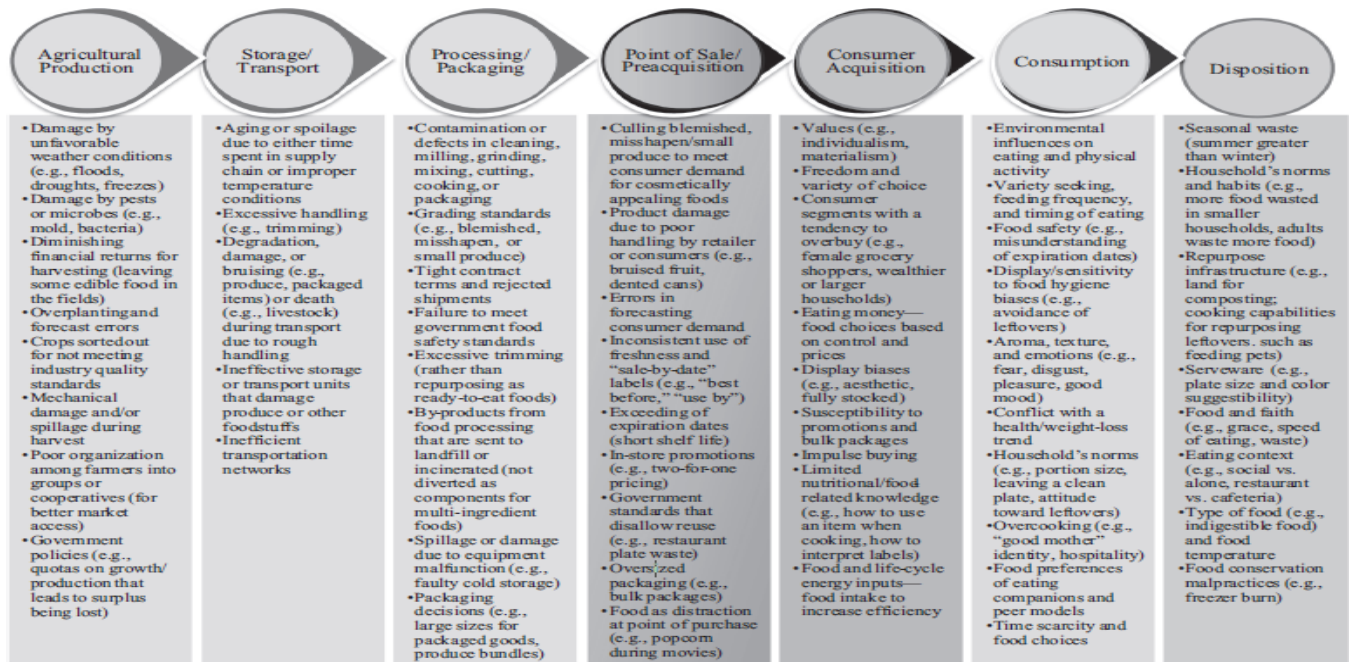


Figure 2.1: Stages of Food Waste (Block, et al., 2016)

Even with food loss occurring at all the mentioned stages, it is important to access wastage at each stage of the cycle for both developing and developed countries. Figure 2.2 shows that developing countries account for 7 percent of food wasted at the consumption stage. However, it is important to note that urban regions experience great levels of food waste at the consumption stage whether in developed or developing countries (Lipinski et al., 2013).

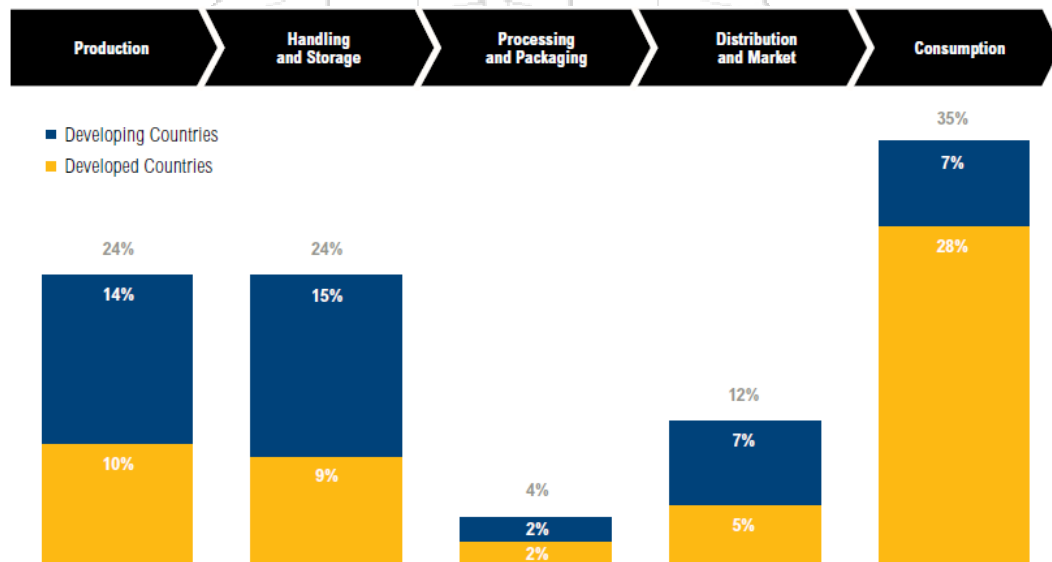


Figure 2.2: Comparison between Food Waste in Developing and Developed Countries (Lipinski, et al., 2013)

2.3 Food Waste in the Hospitality Industry

There is limited literature on food waste problem in Africa, this also means there is limited literature on the methods of preventing food wastage. This notwithstanding, there is considerable amount of food wastage in restaurants, in-flight catering, events such as wedding and corporate events, hospitals and every institution that is in the hospitality industry. Food waste contributes the highest percentage of all waste churned in the hospitality industry (Pirani & Arafat, 2015).

According to United Nations, of the 7.3 billion people on the planet, an estimated 805 million - or one in nine - suffered from chronic hunger between 2012 and 2014. As this happens, in the United States alone, 40 percent of food gets wasted every year—and that amounts to \$162 billion in waste annually this is according to Natural Resources Defense Council. Rescuing Leftover Cuisine, a non-profit organization based in the USA founded in 2013, partners with hotels, restaurants and catering organizations to collect excess food and donate to the homeless. Since its inception, the organization has rescued about 458 tonnes of food from hotels in the USA alone and served 842,659 meals already (Rescuing Leftover Cuisine, 2019).

Pirani and Arafat conducted a research on seventeen restaurants/ hospitality establishments in United Arabs Emirates (UAE) and used the Material Flow Analysis (MFA) to analyze the stages at which food is wasted and quantify the food wasted as well (Pirani & Arafat, 2015). Figure 2.3 shows the results of the analysis at a lunch buffet.

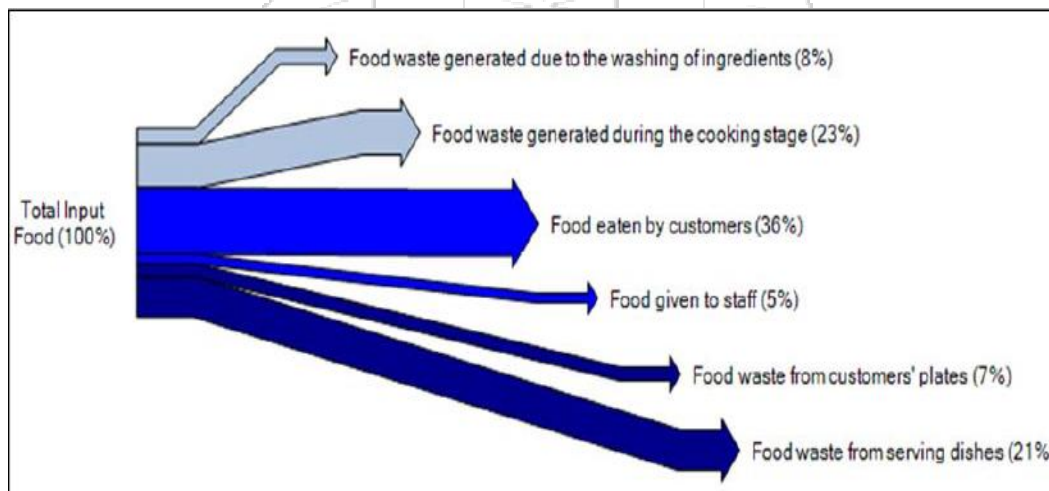


Figure 2.3: Materials Flow Analysis for a Lunch Buffet at a UAE Hotel (Pirani & Arafat, 2015)

They went ahead did a comparison of this waste in a lunch buffet and waste at wedding in UAE still. The results gave a unique perspective as shown in Figure 2.4.

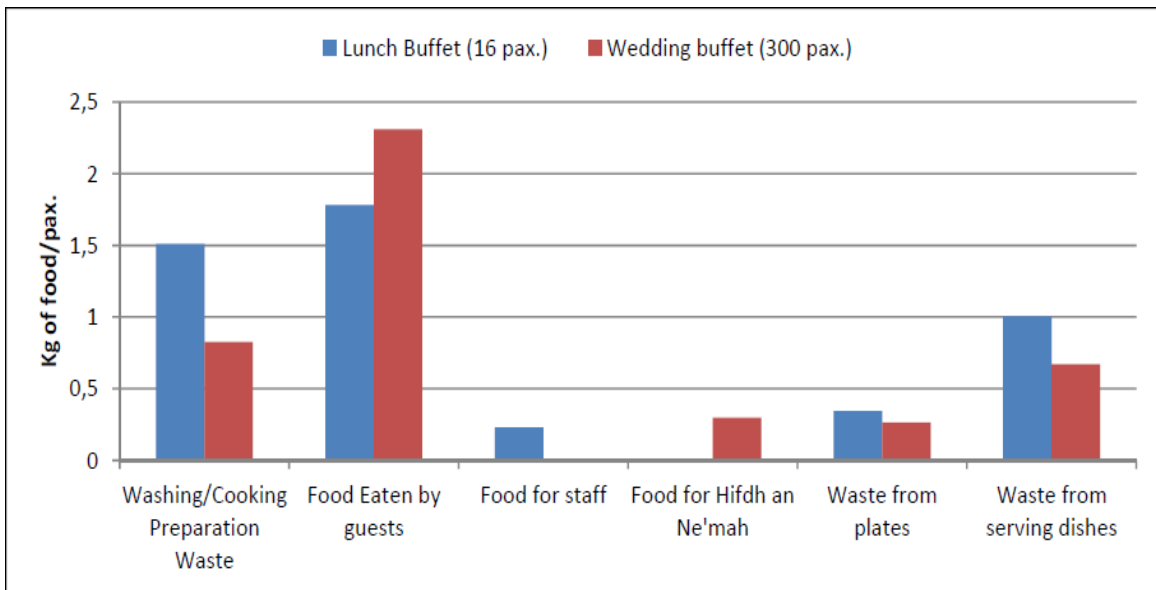


Figure 2.4: MFA Results for a Lunch Buffet Vs. a Wedding Buffet at UAE Hotels (Pirani & Arafat, 2015)

According to Miroso et al. (2016) plate waste is the single largest source of loss for food delivered to foodservice institutions. Most of the food waste that are generated in households are waste such as unused or spoiled cooked food, excess cooked food, vegetable and fruit peelings, beverages that went stale, undesirable raw food, meat scraps, fresh fruit and vegetables and salad (Global Ideas, 2016). Fresh, fruit and vegetables (FFVs) are usually among the most-wasted items, followed by other perishables like bakery and dairy products, meat and fish (Parfitt, Barthel, & Macnaughton, 2010).

2.4 Causes of Food Waste Generation in Households

One-third (about 1.3 billion tonnes) of all the food produced for human consumption goes to waste or is lost annually because of inappropriate practices (Ramukhwatho, Plessis, & Oelofse, 2014). A study on food waste conducted in the United Kingdom, for instance, shows that consumers throw away 31% of the food that they buy and their reason for food being wasted is that it is left unused or that too much food is prepared and also by buying more food than what is going to be eaten (Stop Wasting Food Movement, 2019). Cooking habits of households are the main reason for household food waste. According to the European statistics, households in Europe

spent 12.3% of their household budget on food. People in Romania spent 50% on food (EC Europa, 2018), while South African household spent 14% on food (Government of South Africa, 2012). Some of the reasons that cause this food waste are lack of menu planning before meals and by buying foods that are not on their shopping list. The majority of fresh fruit and vegetables are thrown away because it was not used in time or had gone bad or had passed a date label (EC Europa, 2018).

2.5 Supply Chain Management

Supply chain management (SCM) is a technique that is linked to the adoption of the lean production system (Othman & Abdul Ghani, 2008). Food supply arrangements feature substantial complexity, because of the “trade-offs that need to be made regarding availability, perishability and variability in supply and quality” (Roth et al., 2008, p. 35). Such trade-offs are difficult to handle due to unpredictable process output and quality variations (Trienekens et al., 2012). Aramyan et al. (2007) discussed issues differentiating food supply from other chains: seasonality of production, long production throughput time, and shelf-life constraints. These conditions make food supply “more complex and harder to manage than other supply chains” (Rajurkar & Jain, 2011, p. 34). Opara (2003) characterized the agro-food sector as fragmented, involving a diverse range of enterprises: farmers, processors, marketers, and distributors. Accordingly, Aramyan et al. (2007, p. 304) argued that for improvements of food supply “there is a need to look outside the boundaries of individual firms.”

Supply chain management (SCM) principles have received increasing attention in the food sector (Opara, 2003). Van der Vorst et al. (2007) concluded that managers increasingly realized the significance of “successful coordination, integration, and management of key business processes across members of their supply chains.” However, Aramyan et al. (2007) claimed that SCM application is particularly difficult in the food sector and identified four indicators relevant for performance: efficiency, flexibility, responsiveness, and food quality. Each criterion puts specific requirements on the design and management of supply arrangements, causing tensions and conflicts since organizations tend to prioritize their own goals.

Thus, several authors advocate a network approach for improved understanding of food supply, however this has not yet been done. Therefore, the next few paragraphs are going to assess the industrial network theory with a concentration on ARA model (activities, resources, and

actors). This approach for analyzing industrial reality distinguishes between three central dimensions of the business landscape: the activities undertaken, the resources used for these activities, and the actors undertaking the activities and controlling the resources. In reality, the three dimensions are deeply intertwined. However, by applying three different lenses on a complex context, the ARA model has shown its usefulness for analyzing various business processes and situations, such as technological development, business-to-business marketing, purchasing and supply management, physical distribution and logistics (Håkansson et al., 2009).

2.6 The ARA Model

This is a framework that analyses industrial realities by differentiating three dimensions of the business that are intertwined. These are activities undertaken, resources utilized while undertaking these activities and actors that are undertaking the activities and controlling the resources (Gadde & Amani, 2016). Several researchers have pointed out the importance of the three dimensions of the ARA model.

Caiazza et al. (2014, p. 464) highlighted the role of multiple and interdependent activities in production, processing, and distribution in the efforts “to take an agricultural product from the initial stage of production to the final consumer.” The complexity of the actor layer has been described in terms of “suppliers of inputs such as seeds, chemicals and machinery, farmers and other agricultural service providers, processors of agricultural goods, such as manufacturers of food and beverages, trading companies dealing with agricultural commodities, and retailers, such as supermarket chains” (Caiazza & Volpe, 2012, p. 922). Finally, Koops et al. (2002) emphasized the importance of the resource layer by pointing out the complex nature of resource constellations and their impact on both a firm’s product mix and the design of its processes. Below, central features (CF) of the three network layers and the associated concepts for analyzing FSNs are discussed.

2. 6.1 Activity Layer

The activity layer houses activities to be undertaken and they have interdependencies that are in two forms; serial interdependence and parallel interdependence (Håkansson & Snehota, 1995). Serial interdependence implies that activities have to subscribe to a certain sequence to be undertaken, which means one activity has to finish first before another starts (Gadde & Amani, 2016). Parallel interdependence involves activities of the same type for example materials handling

at a specific stage in the manufacturing and distribution processes. Increasing similarity of activities enhances the scale of the operations, reducing the cost of the activities.

Coordinating activities is very important in handling interdependencies and the biggest challenge is handling the combined effect of two interdependencies (Gadde & Amani, 2016). Organizations try to be as effective as possible on every activity and most times than not tend to make operations as similar as possible. As this happens, customers on the other hand increasingly demand for individualized solutions making the situation even more complex. This clearly shows there need to be a good balance between what the customers need and the operations available (Håkansson & Snehota, 1995).

2.6.2 Resources Layer

The most important feature in this layer is heterogeneity of resources which means value of a specific resource element is determined by its utilization (Gadde & Amani, 2016). For effective resource exploitation deals with resource combination and knowing what type of resources will be combined is the first issue one has to address. From a network perspective, one aspect concerns combining firm-internal resources with external resources accessed through others (Håkansson & Snehota, 1995). For example, Van der Vorst et al. (2007) argued that the first key decision is determining the key supply chain members with whom to connect to gain access to their resources. For business in general, external resources have become increasingly important.

The strategic responses to these conditions have been specialization and outsourcing, making the single company dependent on the resources of business partners (Gadde et al., 2010). Access to such resources provides consequences in the actor layer, as discussed below. Another aspect concerns combining physical resources, such as infrastructure, machinery, and vehicles with organizational resources in terms of knowledge, skills, and intellectual capabilities. The second issue in resource combining deals with the forms of connections between the resource elements – or the interfaces between resources (Håkansson et al., 2009). The more two resources are adapted to each other, the better they will fit together through the improved connection. On the other hand, resources with such specialized interfaces will be difficult to combine effectively with other resources. As with activities, there is a trade-off in resource combining between standardization and individualization requiring managerial handling (Gadde & Amani, 2016).

2.6.3 Actor Layer

Engagement of actors enables resources combination and coordination of activities. As the name suggests, actors act meaning they carry out activities together with other actors. They are goal oriented and act towards achieving their goals that are transformed into intentions (Håkan, 2011). Actors are individuals or a group of individuals forming say a department or an organization. The interaction between the actors is of paramount interest for the prosperity of any business or organization. The interaction can be close and frequent or distant and sparse, with accompanying consequences in terms of adjusted activities and adapted resources (Gadde & Amani, 2016). Close and frequent interaction establishes bonds between the actors through the links between their respective activities and the ties between their resources (Håkansson & Snehota, 1995). Relationships featuring such patterns are identified as “high involvement” relationships (Gadde & Snehota, 2000). Distant and sparse interaction implies a “low involvement” approach, associated with limited actor bonds, resource ties, and activity links.

2.6.4 Approaches to Food Waste Reduction

Extended Shelf Life

Extending shelf life is one of the ways of tackling the food waste problem globally. Preservation techniques such as chilling, freezing, pasteurization, packaging and sterilization not only make products last longer but also improve their quality and nutritional value (Gould, 1996).

Lindbom et al. (2014) showed how a dairy producer was able to triple shelf-life for cream and yogurt through novel packaging techniques. Yogurt features substantial product variety, and the waste amount varied depending on the demand for the various flavors. For low-demand yogurts, it was important to capture potential economies of scale. Therefore, these yogurts were produced in large batches as seldom as possible, which caused waste problems through longer storage. Accordingly, potential benefits could not be fully exploited since part of the extended shelf-life was lost through reduced production frequency.

From the perspective of the ARA model, the example illustrates the inter-relations between the three network layers. Firms tried to reduce the level of waste by modifying the features of the central resource – the food product. Technological development enabled modifications extending potential shelf-life. However, the resource layer was also affected by other dynamics, dramatically increasing product variety regarding product features, packaging sizes, and recipes (Van Donk,

2000; Doganis & Sarimveis, 2008). The assortment expansion satisfied customers' demand for product differentiation but affected the activity layer in terms of reduced similarity of activities and lower economies of scale for producers. Extended shelf-life allowed food processors to improve economies of scale by reducing production frequency, thus increasing the similarities through larger batches. Yet the same actions reduced actual shelf-life since the imbalance between production and consumption activities was handled through warehousing. This trade-off between activities was not entirely negative because inventory-carrying costs in food supply have traditionally been considered below the cost of lost sales (Ketzenberg & Ferguson, 2008).

The analysis shows that prolonging potential shelf-life does not necessarily affect the resource layer positively by reducing waste. On the other hand, extended shelf-life may contribute to efficiency by enabling conditions for increasing the similarity of activities through reduced production frequency and larger batches. However, complex consumption patterns, together with a long chain with several storage points, imply that shelf-life extension may not guarantee consumption before products have reached the "best before date."

2.7 Existing Solutions

2.7.1 Rescuing Leftover Cuisine

Rescuing Leftover Cuisine is a non-profit food rescue organization, operating in 12 cities in the United States of America (USA) and headquartered in New York City. It helps manage food wastage by partnering with hotels that report excess food that is collected and donated to homeless shelters in the cities they operate in (Rescuing Leftover Cuisine, 2019). More to this, Rescuing Leftover Cuisine provides services such as food waste consulting, excess food delivery, co-branding services, and tax credit assistance. It mainly helps manage food waste using three main approaches;

- i. Identify homeless shelters of a needy community and proactively find restaurants, hotels, and catering companies with excess food in that vicinity that could help support these disadvantaged communities.
- ii. Using a web application, the partner food providers report when excess food is occurring. The web application is used to engage community members by providing information on when and where excess food is available.

- iii. They aim to eliminate as much food waste as possible and bring the remaining excess food to where it is needed most. They use the data of when food waste occurs in the analysis of what types of food waste could be avoided, and Rescuing Leftover Cuisine suggests ways that partner food providers can reduce waste at its root (Rescuing Leftover Cuisine, 2019).

2.7.2 Saving Grace Initiative in Abu Dhabi (UAE)

This is an initiative founded in 2004 by UAE Red Crescent Authority to help reduce food waste in Abu Dhabi which stands at 19 percent of all waste reaching the country's landfills (Todorova, 2013).

The initiative collects leftover food from restaurants, cafes, large gatherings such as weddings, palaces, hotels and catering companies and distributes it to hundreds of needy families and labor camps instead of taking it to waste. In 2012, the program delivered 175,000 meals to needy families and laborers (Pirani & Arafat, 2015).

This solution greatly solves the food waste problem by sharing the left-over food with those in need. However, it has limitations on the fact that it does not in any way provide data or give recommendations to the hotels on ways on reducing the food wasted.

2.7.3 Food Panda

This is a global platform that allows people to order for food online. The platform was founded in 2012 and incorporated as a company and currently has operations in more than 450 cities worldwide with the headquarters sitting at Berlin, Germany (Food Panda, 2019). It has partnered with more than 25000 restaurants worldwide and has a team of about 2500 people spread across three continents. The platform is available as a web application and as a mobile application. The user interacts with the platform in four simple steps namely;

- i. Search – The user keys in their address and the platform suggests restaurant close to the area keyed in so the user selects the restaurant he/she desires.
- ii. Choose – The user gets a list of foods on the menu of the restaurant selected, the price and the expected delivery time.
- iii. Pay – After the user selects the food, he/she goes ahead and pays via their secure online platform.

- iv. Enjoy – After payment is made, the platform prompts for delivery of the food to the user immediately.

Refer to screenshots of the applications under Appendices

2.7.4 Jumia Food

Jumia Food was formerly known as HelloFood and it enables users to order food online from a list of several restaurant near them and deliver the food on time. Jumia Food presents online menus of various restaurants, hotels and coffee shops the user then goes to the website, selects their present location, select eatery of their choice, browse the menu, place food orders, and waits to have the food delivered to their doorstep, which may be at home or at work. Payments are made on delivery either through Mobile payment or cash payment (Jumia, 2019) . Refer to screenshots of the applications under Appendices

2.8 Gaps and Limitation on Existing Technology

From the literature discussed above, food wastage is a problem globally and Nairobi is no exception. Most of the existing solutions only help solve delivery of food that the restaurants prepare for customers. Jumia and Food Panda specifically are e-commerce platforms, with both a web and a mobile application, that allow restaurants to put up their meals and for users to make orders online for quick deliveries to their doorsteps. However, they only allow for ordering of freshly prepared meals only as opposed to excess meals from the restaurants. Which brings out the gap in that they do not allow restaurants to put up meals that are in excess after their day's sale or plate waste for animal food. Rescuing Leftover Cuisine and Saving Grace Initiative solves the food waste problem as perfectly as this study proposes but there is a gap in that the solution has been implemented in United States of America and Unite Arabs Emirates respectively and does not serve Africa leave alone Nairobi, Kenya. More to that, the two programs do not give the hotels insights that help them better prevent or put measures to reduce food wastage.

2.9 Conclusion

This chapter has had a run through the problem statement, discussing food wastage in the hospitality industry. The existing solutions and technologies have been reviewed exposing their limitations and hence paving way for the possibility of adoption of combination of technologies in the existing models for the proposed system. This being the case, this study came up with an application that allows restaurants to put out food left over at the end of day for people to book

and collect. More to this, the platform offered insights to participating restaurant using collected data to help them make data driven decisions in their effort to reduce waste in their kitchens.



Chapter 3 : Research Methodology

3.1. Introduction

Research design for this study was performed using qualitative and descriptive research with the location where the study took place being Strathmore University. Purposive sampling was used to choose the respondents who would participate in the study, and once the data had been collected and analyzed, the requirements were grouped into functional and non-functional requirements. The methodology that was used to develop the solution was prototyping.

3.2. Software Methodology

The software methodology used is prototyping model where a prototype (an early approximation of a final system or product) is built, tested, and then reworked as necessary until an acceptable prototype is finally achieved from which the complete system or product can now be developed. The reason for choosing this method is because it ensured that all requirements of the system were captured gradually during the whole implementation process. Figure 3.1 is a flow chart showing the steps that were followed in this methodology.

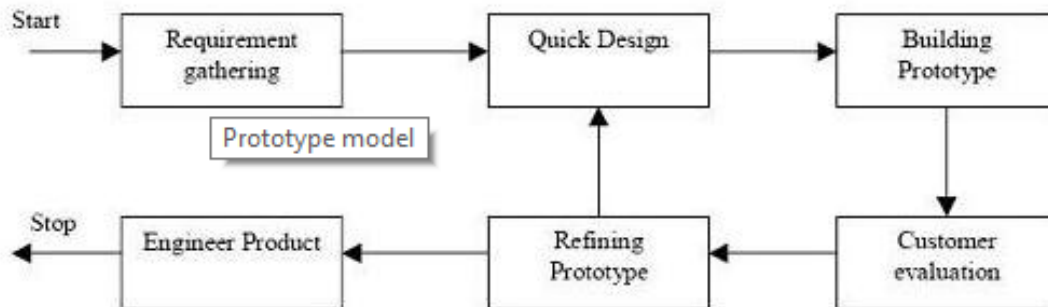


Figure 3.1: Prototyping Model (OMG, 2007)

3.2.1 Planning Phase

This phase was important in determining what was required to make the study a success. It laid out the tasks and all the resources needed beforehand to successfully build the system.

3.2.2 Requirements Elicitation

A feasibility study is an assessment of the practicability of a proposed plan, method or a solution. It was done through reviews of relevant literature on existing systems related to food

wastage. The study was performed to analyze and evaluate the impending solution of the proposed system.

3.3 System Analysis and Design Methods

System analysis and design methods guided the researcher to understand what is needed to analyze data flow systematically, process data, store data and output information in context of the study (Kendall & Kendall, 2013).

Unified Modelling Language (UML) was used as the modelling language. This aided in modelling analysis and design diagrams and make the user requirements clear. Use case descriptions and diagrams were used to model system functionality. The System Sequence Diagram modeled the System Flow showing data passing between main entities of the system. Various entities with corresponding attributes and methods of implementation were modelled using Class diagrams. The Entity Relationship Diagram was used to model the database showing tables, attributes and relationships. The Database Schema modeled the table structure showing fields, data types and descriptions.

3.4 Application Implementation

The prototype comprised of development of a mobile and web application connected to a central database. Below are approaches that were employed in the development of the application:

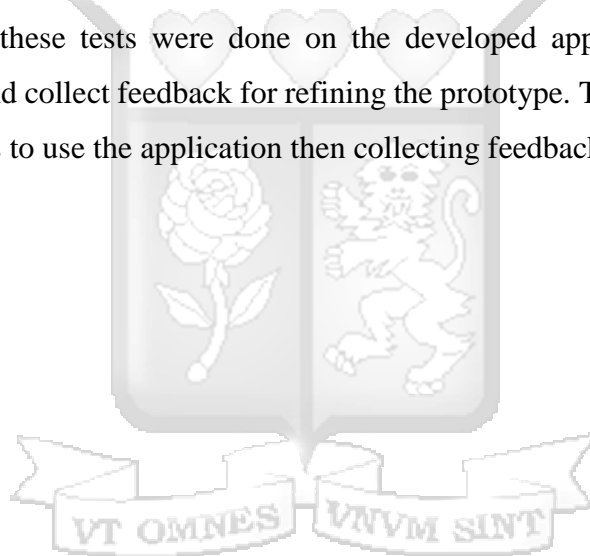
- i. Mobile Application - the Operating System for the mobile application implementation was Android. The source code was written in JavaScript using Framework 7 Vue. The application was compiled using the Android Studio and tested using an Android device. The application was optimized for Android version 6.0.0 compatible with Android devices on minimum 5.0.2. JSON was used as the web service that provides the interface between the Android application and the database.
- ii. Web Application - the web-based application was developed using Python programming language on Django Framework. The website was hosted online on Google App Engine. Reasons for using Python were; it is an open source platform, it is platform independent; it supports all major webservers and databases; it has multiple layers of security to prevent threats and malicious attacks.
- iii. Database - the database was developed using the PostgreSQL. The reasons for using PostgreSQL were; it is an open source platform; it is fully compatible with Python and

other platforms; it is secure in that all passwords are encrypted before storage restricting unauthorized access to the database.

3.5 Application Evaluation and Testing

The prototype went through the following tests to find out whether it is in tandem with the specified goals of this study:

- i) **Functional Tests** - functional and non-functional tests were performed on the prototype mobile application using an Android device and a browser for the web application, ensuring that all requirements are met by the application.
- ii) **Compatibility Tests** - compatibility tests were performed on different mobile and web-based applications on different Android based platforms and browsers, respectively.
- iii) **User Tests** - these tests were done on the developed application to measure user satisfaction and collect feedback for refining the prototype. This was done by allowing different users to use the application then collecting feedback from them.



Chapter 4 : System Design and Architecture

4.1 Introduction

This system was designed using Unified Modelling Language and it involved the design of the system architecture both the front-end and back-end sides of the application outlining the various requirements needed for the implementation of the application. This involved the presentation of the context diagrams, sequence diagrams, use case diagrams, entity relationship diagrams (ERD) and wireframes.

4.2 System Requirements

Below are the functional and non-functional requirements of the system.

4.2.1 Functional requirements

Front-end Functional Requirements

- i. Registration – Once the user installs the application on her or his phone, he/she can register to get a user account. After submitting the details, validation takes place and the user can login and access all the services on the application.
- ii. Login / Log out – The user should be able to login to the system using their user account details and have access to the list of meals available and place orders.
- iii. View meals available – Once a user is logged in, he can browse through the list of meals available for sale.
- iv. Order a meal – Once a user likes a meal, he can place an order for it and this marks the meal as booked and can be removed from the list of meals available.
- v. Pay for a meal – Once the user has placed an order, if the meal is not free but for sale, the user should be able to pay through the system.

Back-end Functional Requirements

- i. Hotel registration – The administrator who is one of the backend users should be able to register new hotels and provide them a user account.
- ii. Upload a meal – the hotels should be able to upload a meal that is available in their hotels for sale or even to offer for free since it's the leftovers after a day's sale.
- iii. Delete / edit a meal – the hotels should also be able to edit or delete a meal in case there is an error in the information provided.

- iv. Generate reports – the administrator should be able to generate reports from the system showing informative trends that would be beneficial to these hotels to reduce food waste.

4.2.2 Non-functional Requirements

- i. Security – the system is secure to avoid interception from hackers. User authentication is key to help make the system secure.
- ii. Reliability – the system is highly reliable especially when there is a fault to remain tolerant even at such an event.
- iii. Availability – The system has high availability to allow fast execution of requests and fast resolution of these requests.
- iv. Performance – The general performance of the system is exceptional, with short time to fetch data from the database and store data to the database.
- v. Data retention – the mobile application has a cache to store frequently accessed data and reduce the number of requests to the database directly.

4.3 System Design

The System Design presented the proposed solution in a logical manner using different design diagrams. It consists of six components:

- i. Data Flow Diagrams
- ii. Use Case Diagrams
- iii. Entity Relationship Diagram
- iv. Sequence Diagram

4.3.1 Data Flow Diagram

A data flow diagrams showed what kind of information would be input to and output from the system, how the data would advance through the system, and where the data would be stored. However, it does not show information about the timing of process or information about whether processes would operate in sequence or in parallel unlike a flowchart which also shows this information. Figure 4.1 shows the two levels of data flow diagram for the food application.

Level 0 Data Flow Diagram (Context diagram)

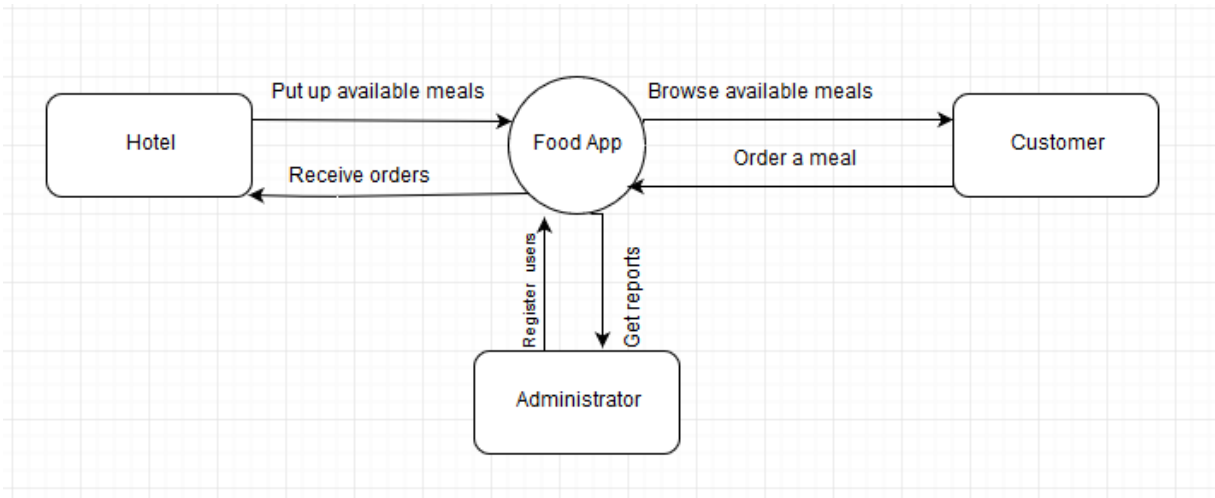


Figure 4.1: Context Diagram

Level 1 Data Flow Diagram

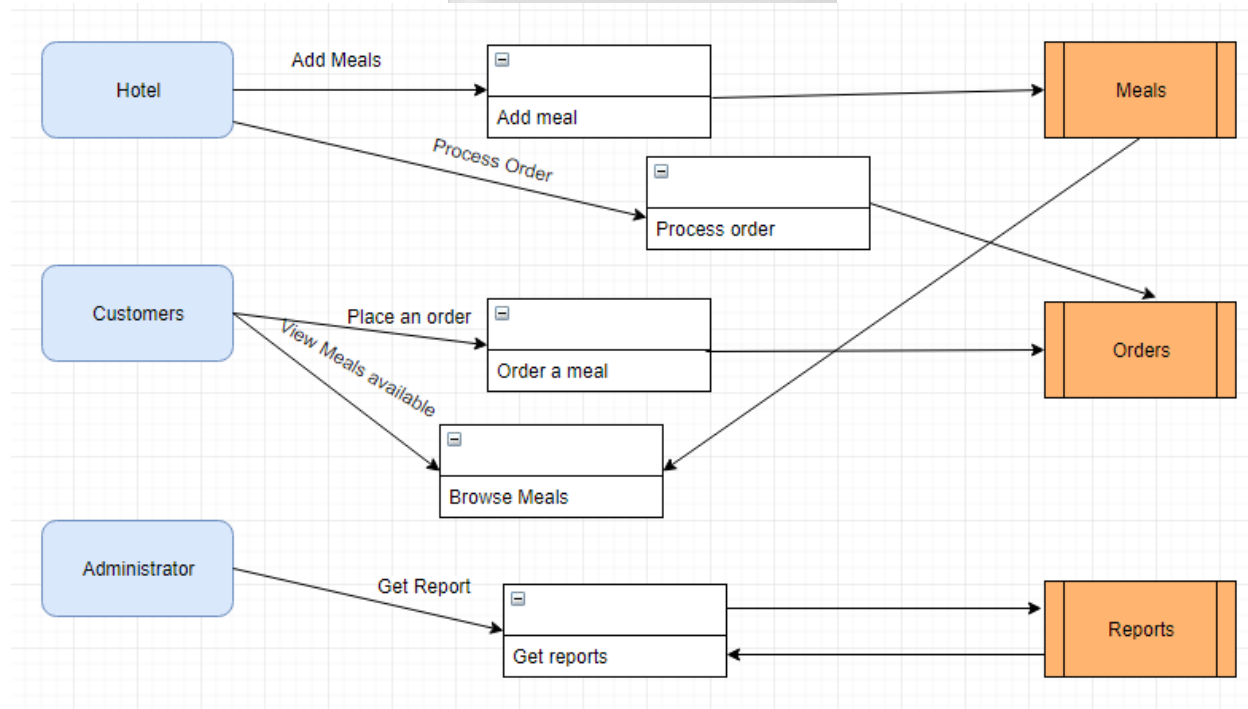


Figure 4.2: Level 1 Data Flow Diagram

4.3.2 Use Case Diagram

This is a behavioral diagram that shows the functionality provided by a system in terms of actors, their goals as represented by use cases and any dependencies on those use cases. The main actors of the system were the hotels that upload meals on the application, customers who booked

the meals to pick or get the meals delivered to them and the administrator of the system who monitors the system and generates reports. Below are the main methods in the system:

- i. Login/Log out – users of the system can login and log out of the system.
- ii. Upload meals – hotels can upload meals on the platform
- iii. View meals available – Customers can view all the meals available on the application
- iv. Order a meal – Customers can place an order for a meal they like
- v. Pay for a meal – Customers can pay for meals that are on sale
- vi. Edit meal details – hotels can edit meal details posted on the application
- vii. Create reports – the administrator can generate reports from the system
- viii. Create hotel profiles – The admin can create profiles of hotels in the system so they can begin uploading meals on to the platform.

Below are the use case descriptions for the above use cases. Table 4.1 shows the Login/Logout use case description.

Table 4.1: Login/Logout Use case Description

Use case name	Login/Log out
Description:	A user can login and logout from the system
Primary Actors:	Customer, hotel
Precondition:	User must enter her or his username and password
Post condition:	Username and password must exist in the database.
Typical case of Events Actor Response <ol style="list-style-type: none"> 1. Provide username and password. 2. Click logout. 	System Response <ol style="list-style-type: none"> 1. Logged in successfully. 2. Logged out successfully.

Table 4.2: Upload Meals Use Case Table

Use case name	Upload meals
Description:	Hotel/restaurant uploads leftover meals available
Primary Actors:	Hotel/restaurant
Precondition:	Hotel/restaurant must be logged in
Post condition:	The available meal table in the database is updated.
Typical case of Events	System Response
Actor Response	1. Confirmation message of updated meal.
1. Details of the meal are added to the database.	

The other use case diagrams are illustrated on the Appendices section of this dissertation.

Figure 4.3 shows the use case diagram illustration for the system.

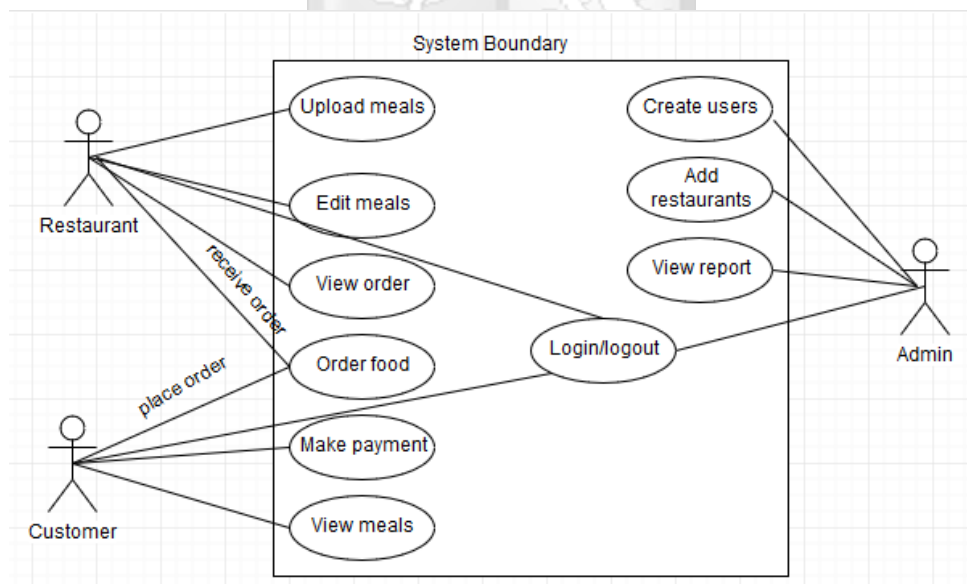


Figure 4.3: Use Case Diagram

4.3.3 Sequence Diagram

A sequence diagram is an interaction diagram that shows messages exchanged and their corresponding occurrence specifications in the lifelines of a system (OMG, 2007). The sequence diagram on Figure 4.4 shows the messages in the system and the lifelines involved.

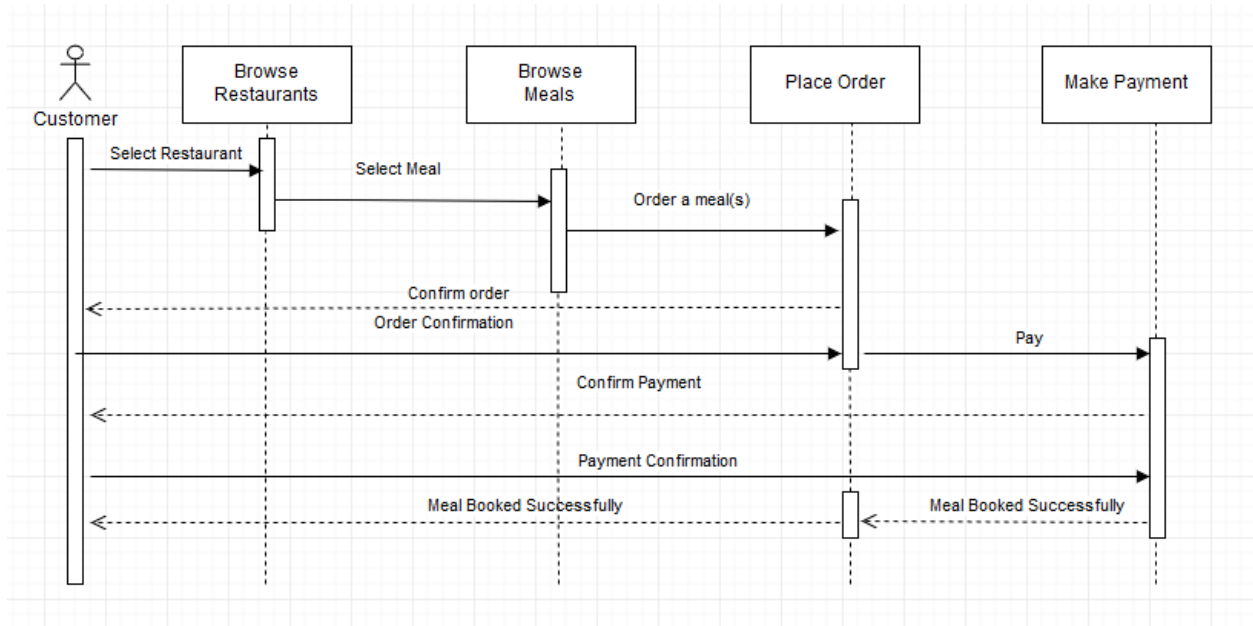


Figure 4.4: Sequence Diagram for the Solution

4.3.4 Entity Relationship Diagram

An Entity- Relationship diagram gives an overview of entities such as people, objects or concepts in a system and how they relate or depend on one another. The entities in this system were; customer, restaurant, order, meal and bill. Figure 4.5 shows the entity relationship diagram for the system.

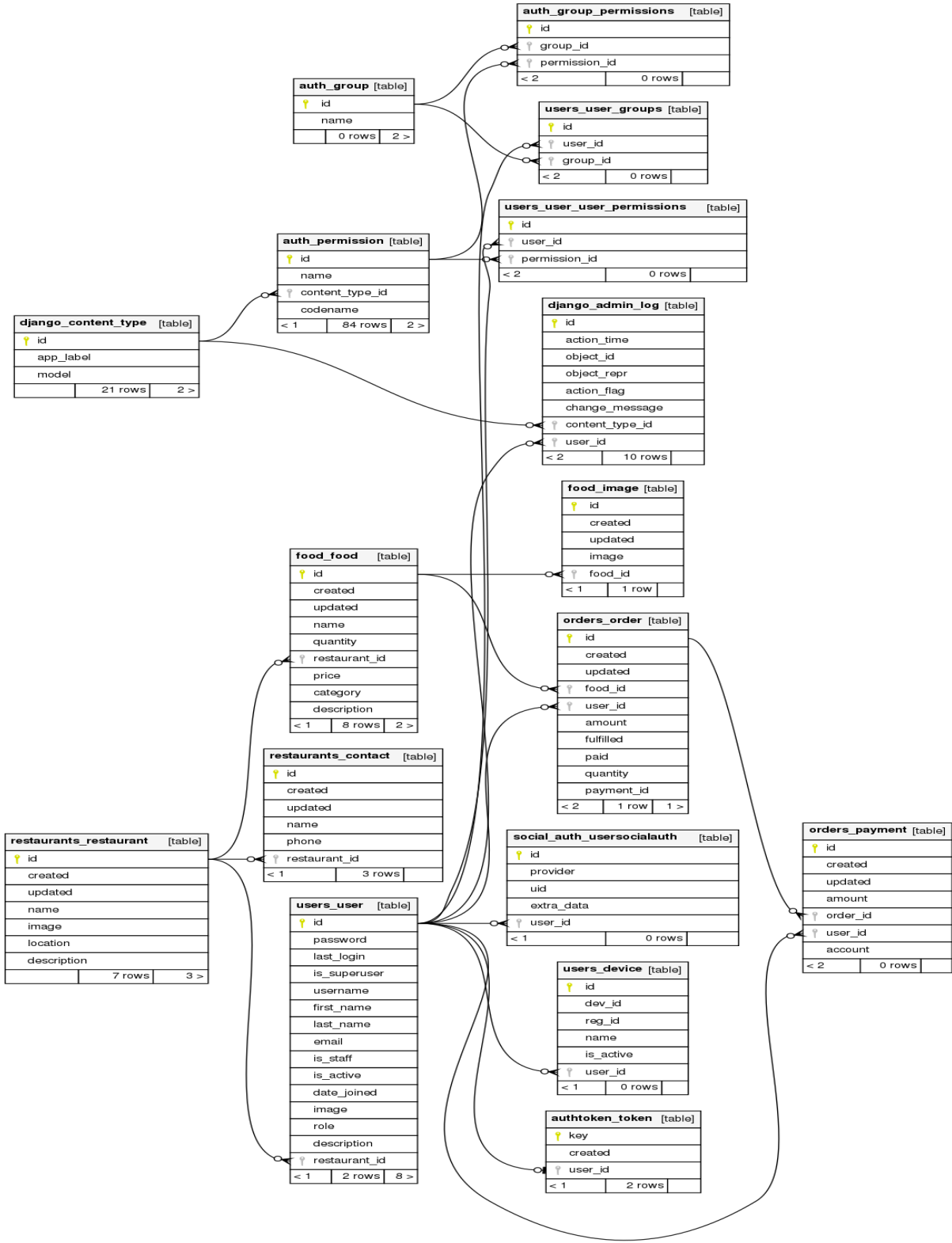


Figure 4.5: Entity Relationship Diagram

4.3 System Architecture

The front-end user of the system is the customer. He/she is able to scroll through the meals put up by hotels and be able to place an order or rather book the food. If the food has been put up for sale at discounted prices, they are able to make payment via the system.

The back-end users for this system are the hotels uploading the meals on the system and the system administrator who can monitor the system and generate reports. The hotels are able to login via the back-end web application and upload meals ready for pick up every day. Once customers book the meals or place their orders, they can get these notifications and pack the food ready for pick up.

The administrator is also a back-end user who creates profiles for the hotels that upload the meals and generate reports from the system.

4.3.1 Three Tier Architecture

This system was built on the three-tier model which has three layers and allows for code reuse. These layers are;

- i. Presentation tier – This is the user interface the user interacts with. It's the top-level interface of the system. It is built on a graphic user interface for easy interaction.
- ii. Logical tier – This is the layer that controls the applications functionality by performing detailed processing.
- iii. Data tier – This is the tier where information is stored and retrieved. It's the tier that keeps data neutral and independent from application servers or business logic.

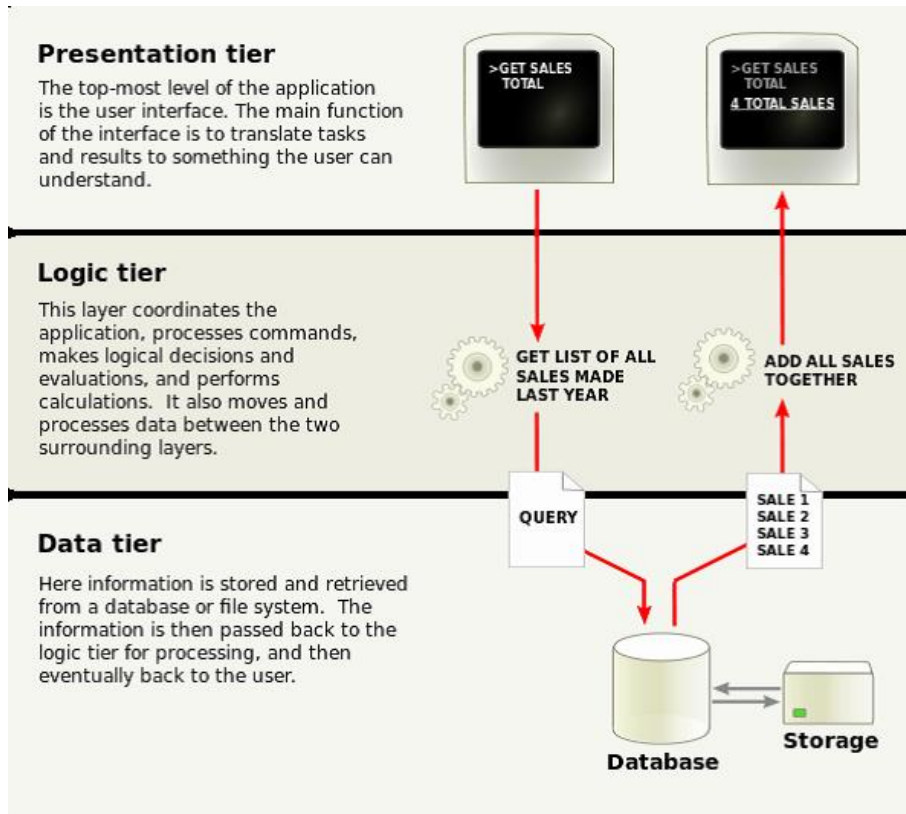
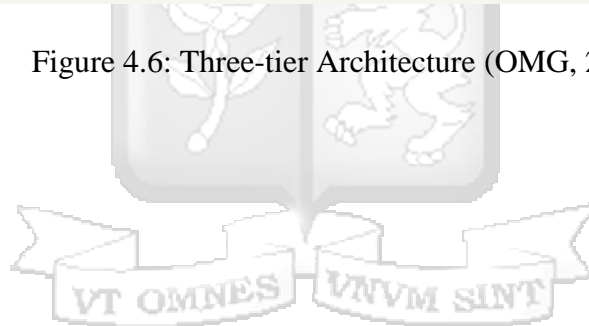


Figure 4.6: Three-tier Architecture (OMG, 2007)



Chapter 5 : Prototype Building and Testing

5.1 Introduction

There are three main ways to develop mobile applications, they can be developed as native applications, web applications or hybrid applications. This variation is brought about by the fact that cell phones use varied Operating Systems (OS). For example, iPhones use IOS Operating System, Samsung phones use Android Operating System and Blackberry uses Blackberry Operating System.

Native applications are developed for a specific target platform, using that platform's Software Development Kit (SDK) and frameworks, and the app is tied to that specific phone Operating System (Ottka, 2015). For example, an Android application is developed with Java using the Android SDK and the APIs provided by Android and uses platform provided elements for rendering the UI (Ottka, 2015), same as iOS using Objective-C programming language and Apple's framework. The limitation of developing an application natively is having to develop an application for every platform there is since users will use different phones using varied operating systems.

Mobile Web applications (Web apps) are implemented using HTML, CSS, and JavaScript, they use the browser as their runtime environment and thereby capitalize on the good browser support of mobile platforms (Henning, Hanschke, & Majchrzak, 2013). When using this approach, developers implement their application as one Web site optimized for mobile devices, which the Web browser then interprets. Due to the standardized technologies, the Web site can be accessed in a similar way by mobile browsers on all platforms. However, mobile Web apps cannot use device specific hardware features such as camera or GPS sensor since they cannot be installed on the mobile device but are retrieved via a URL.

To resolve the limitations of mobile web applications, while still satisfying the desire to employ common Web technologies, hybrid approaches emerged as a combination of Web technologies and native functionality. Their runtime environment largely consists of a Web rendering engine, wrapped in a native engine. The source code of hybrid apps uses similar technology like Web apps but additionally has access to an API for platform-specific features. At runtime, the platform's Web view—essentially a browser without user controls—interprets the

source code to display Web pages. All calls to hardware APIs are relegated to the native wrapper. Hybrid apps are packaged natively and thus can be (and must be) installed on the device, unlike Web apps. While their look & feel mostly resembles that of Web apps, they have access to platform-specific features.

The advantages of hybrid apps are the reasons this application was created using Framework 7 Vue that is built in JavaScript for the frontend and the backend created using Python programming.

5.2 Implementation Environment

5.2.1 Hardware Environment

The mobile application runs on Android devices with the following minimum specifications;

- i. Android version 5.0.2
- ii. CPU speed 1.3GHz
- iii. RAM 2.0GB
- iv. Internal Storage 2.0Gb

The web portal runs on any computer with a browser however it is optimized to run on Google Chrome and Mozilla Firefox browsers.

5.2.2 Software Environment

The mobile application was built for Android platform using JavaScript utilizing Framework 7 for the user interface. The application was compiled using Cordova and Android studio Gradle to build the code for the Android platform. The web application for the backend processes was built using Python on Django framework and Django REST Framework for the API that the mobile application interacts with. The application data, for both the web application and mobile application is store in a PostgreSQL database and the application is hosted on Google Cloud.

5.3 System Implementation

The system was implemented as both an Android mobile application and a website backend known as *Foodie*. The website backend enabled the administrator to manage users, meals being uploaded to the application and view reports which is useful for analysis of the data in the database.

5.3.1 Mobile Application

The mobile application allows users to view meals from different restaurants that are available for ordering. The user can choose the meals they wish to take up and place an order. The application also allows users to view leftover food from various restaurants that they can place orders on and give to their animals such as pigs or dogs. From the application, the user can see a history of their orders and see their profile.

Once a user downloads the application and installs, they first see the splash screen that has the app logo. The user is then prompted to login to the application or create an account. Once they have successfully logged into the application, the user is able to see a list of restaurants to choose from. The user can then select one of the restaurants and see a list of meals available from that restaurant. The meals are displayed with the discounted amount and the number of plates available. The user chooses the meal and they are prompted for the number of plates they wish to order, and they must enter a number smaller or equal to the number of plates available. This is placed on the cart and the user can continue shopping on the application till they are done. After this they go to the cart for checkout and they see the total cost and they can make payment. The app has a prompt asking the user if they are sure they want to make a payment to *Foodie* using MPESA. If they reply with the affirmative, the payment is recorded in the database and they get information on where to collect their meals.

System Components

View Restaurants and Meals Available

This screen shows the list of restaurants available in the application with left over meals available and the meals available. Figure 5.1 shows the view meals available screen of the mobile application.

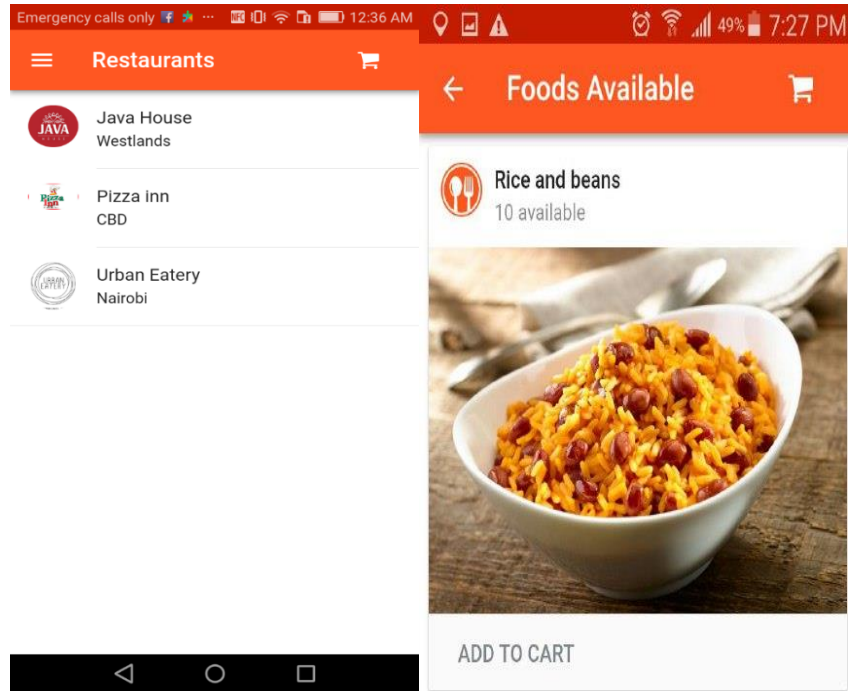


Figure 5.1: View Restaurants and Meals

Placing a Meal in Your Cart

Figure 5.2 shows the process of placing meals in a cart.

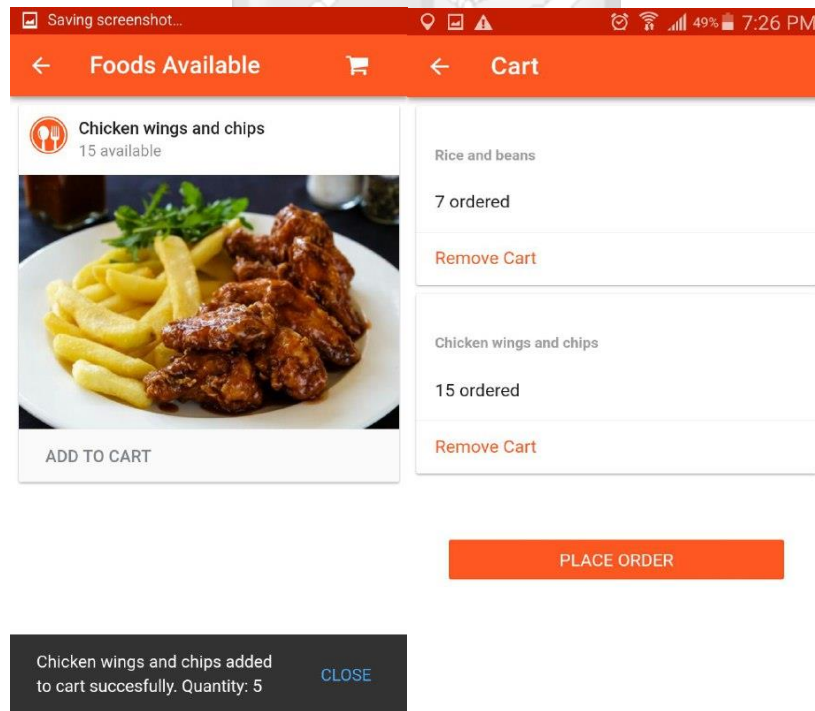


Figure 5.2: Add to Cart Screenshot

Orders and Payment

Figure 5.3 shows orders and payment process.

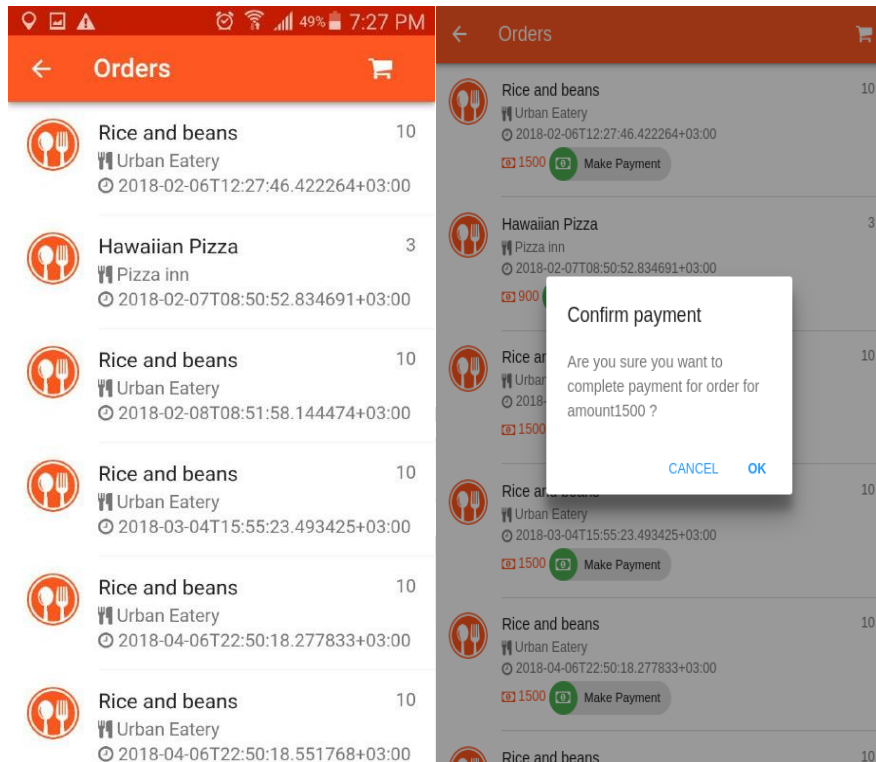


Figure 5.3: Orders and Making Payment

5.4 System Testing

This section describes tests that were performed on both the mobile and web application. Testing was done on four main areas; functionality tests, usability tests and compatibility tests.

5.4.1 Functional Testing

Functional tests were carried to determine whether the system design and its implementation was a success or a failure. Different use cases of the system were tested with results being flagged off as a success or fail. Below are the test cases carried out and their results. Table 5.1 shows the add restaurant functionality test case.

Table 5.1: Add Restaurant Functionality

Utilized use case	Add restaurant
Test Parameters	Filling a form with details of the restaurant then clicking the submit button.
Expected Behavior	Data is added to the restaurants table in the database successfully
Observed Behavior	Data was successfully added to the database
Test Outcome	Pass

Table 5.2: Add Meal Functionality

Utilized use case	Add meal
Test Parameters	Filling a form with details of the meal
Expected Behavior	Data is added to the meals table in the database successfully
Observed Behavior	Data was successfully added to the database
Test Outcome	Pass

Table 5.3: View Restaurant Functionality

Utilized use case	View restaurants
Test Parameters	After logging in the user sees a list of restaurants
Expected Behavior	See a list of restaurants with meals available
Observed Behavior	The user can see a list of restaurants to choose from
Test Outcome	Pass

Table 5.4: View Meals Functionality

Utilized use case	View meals
Test Parameters	After logging in and selecting the restaurant, the user sees the meals available together with the quantities.
Expected Behavior	View a list of available meals in the restaurant, quantity available and price per unit

Observed Behavior	The user was able to view a list of available meals in the restaurant, quantity available and price per unit
Test Outcome	Pass

Table 5.5: Add Meal to Cart Functionality

Utilized use case	Add meal to cart
Test Parameters	Select the meal you want, get a prompt to add the quantity you want then click add to cart
Expected Behavior	The meal is successfully added to cart
Observed Behavior	The meal was successfully added to cart
Test Outcome	Pass

Table 5.6: Checkout Functionality

Utilized use case	Checkout
Test Parameters	Select cart to see list of items in it
Expected Behavior	See a list of items selected on the cart and be able to make payment and have your order placed
Observed Behavior	Payments table and order table should be updated
Test Outcome	Pass

Table 5.7: View Animal Food Functionality

Utilized use case	View animal food
Test Parameters	Login to the mobile app and click the animal food tab
Expected Behavior	Get a list of animal food and quantity from different restaurants.
Observed Behavior	There was a list of animal food available and quantities
Test Outcome	Pass

Table 5.8: View Reports Functionality

Utilized use case	View reports
Test Parameters	Login to the dashboard on the web portal
Expected Behavior	Once the dashboard loads, view graphs of the data in the database
Observed Behavior	Graphs were present on the on the dashboard page of the web application
Test Outcome	Pass

5.4.2 Usability Testing

End users of the application were involved in usability testing. This group defined the target population available to use the system. A total of 26 respondents carried out the user testing practice giving appropriate feedback for the research. 26 respondents were used as these were the only individuals who created time to be a part of the testing exercise. User testing was done to achieve the following objectives:

- i. User friendliness
- ii. functionality
- iii. Aesthetics
- iv. Acceptance

This section focuses on each of the mentioned objectives in detail. The findings are presented graphically for an elaborative visual presentation.

i. User Friendliness

The ease of learning and using the application was tested by potential users. The results were as follows; 90% of the potential users indicated that the application was easy to learn and use. Figure 5.4 shows a summary of the results.

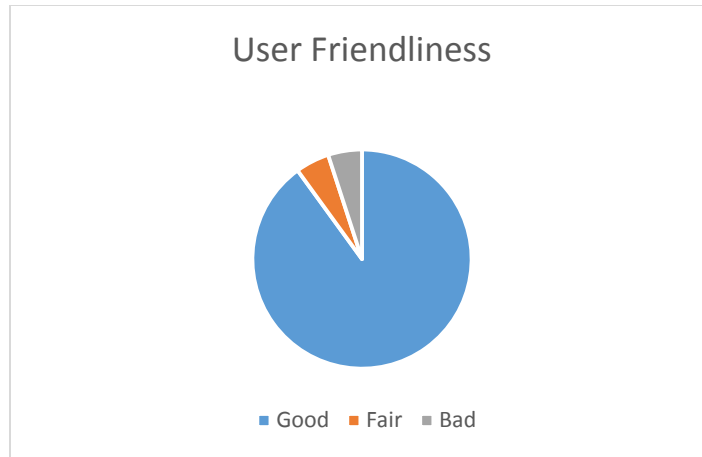


Figure 5.4: User Friendliness Testing

ii. Functionality

Thirty potential users of the application tested the system functionality against the user specifications. 80% of them indicated that they were very satisfied with the application's functionality meaning that the developer achieved most of the user functionality and requirements specification, 20% indicated that they were satisfied with the application's functionality meaning that some of the user specifications were not entirely meet. This result was used to refine the system until an acceptable application was developed. A summary of the results is shown in Figure 5.5.

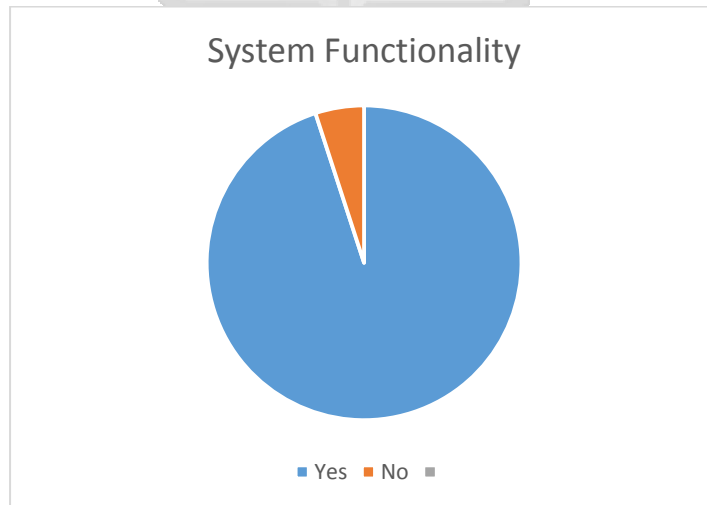


Figure 5.5: System Functionality Acceptance Testing

iii. Acceptability

To measure if the application was great success user acceptance was tested. 90% of the potential users gladly accepted the application for use in when looking for affordable food in restaurants. 10% did not accept the application meaning that there were some aspects about it that they wish would be different. Since majority of the users gladly accepted the application this test was a great success. Figure 5.6 provides a summary of these results.



Figure 5.6: Acceptability

iv. Aesthetics

User interface aesthetics is defined by the look and feel of the application design and flow to its users. 84% of the respondents indicated that the application had an attractive presentation. 14% of the respondents indicated that the application was acceptable while the remaining percentage indicated that the application was not pleasing to the eyes. A summary of the results can be viewed in Figure 5.7.

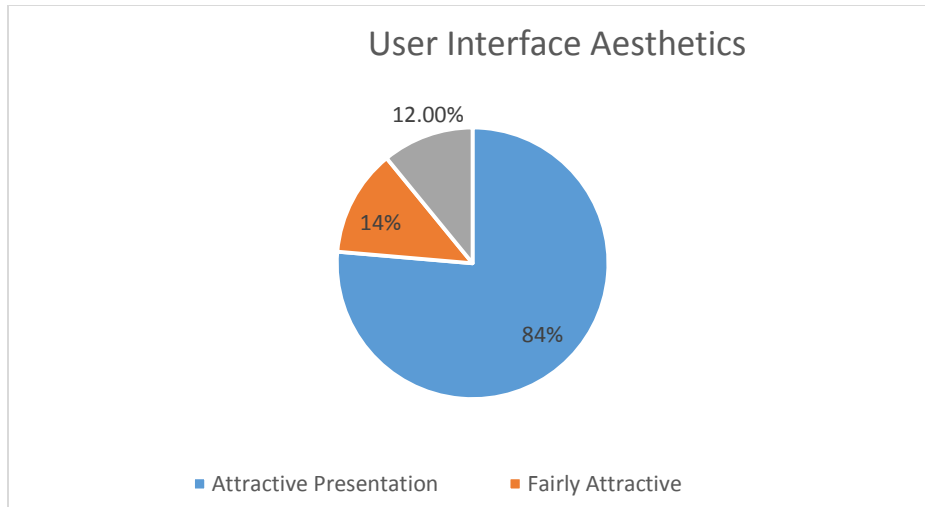


Figure 5.7: User Interface Aesthetics

5.4.3 Compatibility Testing

Compatibility testing was done to ensure that the system; both the mobile and web application are compatible with the existing platforms. Mobile application was tested on the existing Android versions while the web application was tested on the all the major web browsers.

Android Platform Testing

The table 5.9 shows tests conducted on predefined and locally available Android platforms.

Table 5.9: Predefined Available Android Operating System Platforms

Android Platform	Compatible
Android 7.0	Yes
Android 6.0	Yes
Android 5.0	Yes

Web Browser Testing

Table 5.10 shows testing done on available and commonly used web browsers.

Table 5.10: Test Done on Available Browsers

Web Browser	Compatibility
Internet Explorer – Version 4 and above	Yes
Mozilla Firefox – Version 4 and above	Yes
Chrome – all versions	Yes

5.5 System Evaluation and Validation

This evaluation was done to ascertain whether the solution helped restaurants with excess food consumable by humans or animals put it up on the application to help reduce food wastage. Figure 5.8 shows what the users thought of the implementation and if the system solves the problem, we can see that majority of the users were very satisfied that the implementation addresses the problem.

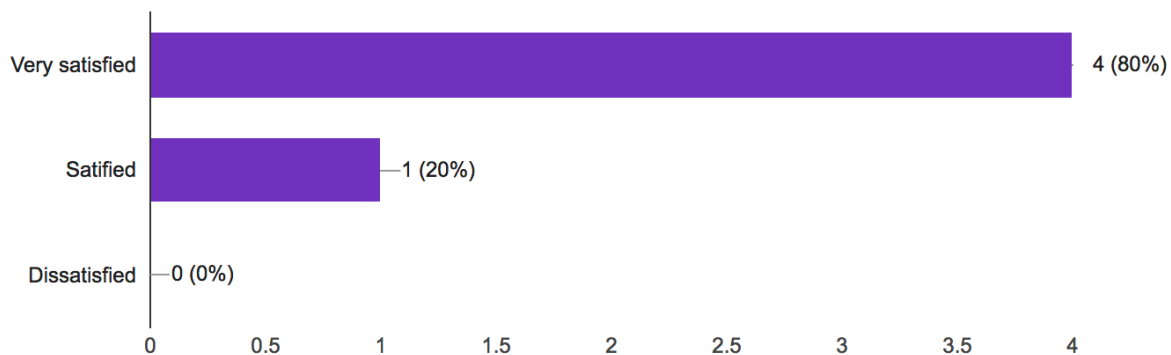


Figure 5.8: Evaluation and Validation of the Solution

5.6 Summary

The system requirement collection stage clarified what functionalities the application would have. This in turn translated to development of an application that met the set objectives and the user requirements also. Hence, all the set objectives were met with the implementation of the application. This was made possible by the methodology used, which allowed iterations while the product is being implemented to ensure all loopholes are closed and ensure the application is working as planned.

Chapter 6 : Discussions

6.1 Introduction

The aim of this research was to provide a solution to manage the food wastage problem in the hospitality industry in Kenya. From the research findings, an appropriate solution that involved developing a mobile application for users who wish to place orders and a web application to upload food available from the various hotels was created. The web application would be for administrators of the platform to upload, edit or delete items on the catalogue and also create accounts for hotels and restaurant to login and check status of their orders. This chapter describes research findings and achievements, how research objectives were obtained and provides a review of the application developed, citing advantages and limitations of the developed application.

6.2 Discussion in Relation to Research Objectives

The first objective was to assess the food wastage problem in the hospitality industry and as discussed in the literature review, food security is still a huge problem in Kenya, and at the same time, food wastage is also an unsolved problem. Which is ironic, that in a country which is not able to feed it people sufficiently, it still suffers from food wastage from the little it has. Hotels serve n-course meals out of which fifty percent of it go to waste, not because the food is non-consumable, but because it was served at a table but not consumed. Take for instance bread and butter as a starter, many are the times all bread is not consumed, but when it's taken back to the kitchen, it cannot be served to another customer since that is not compliant. So, the bread ends up in the waste bin, even if it is human consumable.

The second objective was to review the architectures, frameworks and models of existing food applications in the hospitality industry. There are several applications currently in the hospitality industry that allow users to order food online and have it delivered to them in the offices or homes. However, there's none that allows hotels and restaurants to post their excess food for users to order. There's a similar solution though known as Rescuing Leftover Cuisine that is based in the USA. The solution allows hotels to post their excess food on the platform for donation to the homeless and children homes. This however has not been implemented in Kenya and that where the gap is. The models employed in the existing applications has two sections, one that allows restaurants to report excess food in their kitchens and another that allows users to go through a catalogue and place an order for any of the meals on the catalogue.

The third objective was to create a solution to propose a system that helps manage the food wastage problem in the hospitality industry. The proposed solution was to create a platform where hotels and restaurants can report their excess food, whether for human consumption or for animal consumption and users can access this platform and place an order. Since a huge portion of residents of Nairobi use smartphones, the solution was a mobile application running on Android with a web application for administration. Users can login and check meals available at all the partnering organizations and place an order and all the organizations can report to the administrator the meals they have available and this can be fed to the web application.

The fourth objective was to validate the system and as discussed in above , the system was tested on an Android device and a web browser and the results show that the system met the requirements expected. This validates that the system solves the food wastage problem in the hospitality industry as was the main objective of this study.

6.3 Advantages of the Application as Compared to the Current System

The applications currently in Kenya only offer a platform where restaurants put up their meals for sale. They are all e-commerce platforms for food. *Foodie* has the advantage that it is solving the food waste problem by allowing restaurants to put up leftover food on the platform that is either human consumable or for animals. Since the food being put up is not freshly prepared food, the restaurants can either choose to put it up for free or put it up at huge discounts since the food would have gone to waste any way. The application is also able to offer reports on the various dynamics in terms of orders from each restaurant and kind of meals being captured on the website. With such insights, the restaurants are able to better plan while preparing their meals in the kitchen to reduce waste.

The application solved the food waste problem, and this is the biggest advantage that the application over the others. It allows anyone who has access to internet and a smart phone to get to enjoy food from known restaurants at affordable rates. The application not only allows for restaurants to put up human consumable food but also animal consumable food. This means 100 percent of the left-over food in restaurants is acceptable on the platform and can be used by either animal owners, or just people looking to get good meals at a good discount.

Throwing away food has adverse effects to the environment and the application puts the excess food and left-over food to good use by making it available to people in need of it.

6.4 Limitation of the Application

The application has the following limitations:

- i. The application is only accessible to Android platform smartphone users
- ii. The application requires internet all through to access it.



Chapter 7 : Conclusions

7.1 Conclusions

Food wastage is still a huge problem globally and this research was done to create a solution to help reduce food wastage. The research also sought to find out if the proposed solution, a mobile application that allows restaurants to report excess food and users to place orders, would be efficient and acceptable to solve the problem. This study on food waste problem in Kenya is conclusive on successful implementation and use of the developed application as a tool for reporting excess food in restaurants and allowing users to book the meals. However, there is still need for the government to create and implement measures and policies to ensure that the country has food security and the available food in the ecosystem is not wasted at all.

This study will have impact in the Kenyan industry in that it provides an avenue for restaurants, hotels, supermarkets and any institution in the hospitality industry to offer food as donation to the needy for instance children homes or to just citizens who would want to take up food that is not fresh but still human consumable. Notably, the application also offers a platform for people who rear animals such as pigs or dogs to take up the expired food, leftover food peeling and waste from plates for their animals, ensuring that even the waste that would have been left to the environment to decompose is well utilized.

The study focuses on waste that takes place at the very end of the consumption chain. However, food wastage happens all throughout the process from when farmers harvest their crops to when this harvest gets to the final consumer. Due to limitations of time and resources, this study focused on the waste that takes place at the final stage of consumption.

7.2 Recommendations

The solution solved the immediate issue of connecting restaurants with excess food with those in need of it. However, the researcher gave the following recommendations to better improve the solution:

- i. Include a delivery button by partnering with logistics companies such as *Sendy* to ensure the food gets to the consumers in time.
- ii. Incorporate in-app payment methods for the food being ordered on the application.
- iii. Develop for other mobile platforms such as iOS, Blackberry and Windows

- iv. Develop web application to cater for users using feature phones but have access to a web browser.

One of the president's big four agenda is food security, and while this study looks into ways that can reduce food waste at the consumer stage of the process, there's need to take care of the problem from the stage at which farmers harvest to when the food gets to the final consumer. Studies have shown that more wastage happens at this stage and there is need for further research to ensure food is reduced at all stages of the process, from the moment food leaves the farms to the moment it get to the granaries before getting to the final consumer. To achieve this food security agenda, the government needs to put in place policies that ensures farmers harvests are well coordinated with the needs of the market and technology can greatly aid in this process to ensure that at the time the harvest leaves the market, it finds ready market waiting for it and throughout the transportation process, the viability of the harvest is monitored to reduce wastage by enduring optimum conditions for the harvest during transit.

There is need for further research into consumer habits and how they lead to food wastage at any stage of the process and ways they can be influenced to reduce food waste. In addition to this, it would be helpful to incorporate Internet of Things to the system so that only the food required is harvested in the farms and delivered to the restaurants to ensure only what is needed is delivered.

7.3 Suggestions for Future Research

The researcher recommends that for future research, the hospitality industry should be able to collect data of the eating habits of their customers, frequency on every day of the month to their institutions and using this data, they will be able to prepare the exact amount of food required with little or no waste. This will ensure that the farmers will only deliver to these institutions what they require for that particular time and this will further reduce the wastage from farm products going bad while in the granary.

Food security is still a huge problem globally, ironically, food waste is also a huge problem at the same time with the developed countries having the biggest share of the problem. There is need to bridge the gap through further studies to identify cultural and behavioral habits that may lead to food wastage and ways these can be influence outside of technology.

There is also opportunity for further studies to identify legal implications of restaurants putting up their excess food up for sale at a discount. In an event that a consumer gets affected by this food, does the law protect the restaurant that put up the meal or does it protect the consumer? This would be an interesting study since it could be the reason restaurants have not get warmed up to the idea of sharing their excess food with people who might be in need of it.



References

- Block, L. G., Keller, P. A., Williamson, S., Vallen, B., Birau, M. M., Grinstein, A., . . . Tangari, A. H. (2016). The Squander Sequence: Understanding Food Waste at Each Stage of the Consumer Decision Making Process. *Journal of Public Policy & Marketing*, 35. 10.1509/jppm.15.132. .
- Chrisafis, A. (2016, February 2016). *French law forbids food waste by supermarkets* . Retrieved from The Guardian: <https://www.theguardian.com/world/2016/feb/04/french-law-forbids-food-waste-by-supermarkets>
- Deutsche Welle. (2019, April 29). *Food for thought on World Environment Day*. Retrieved from The GLOBAL IDEAS Blog: <http://blogs.dw.de/globalideas/food-for-thought-on-world-environment-day>
- FAO. (2013). *Food wastage footprint: Impacts on natural resources*. Rome: FAO.
- FAO. (2019, April 29). *SAVE FOOD: Global Initiative on Food Loss and Waste Reduction*. Retrieved from Food and Agriculture Organisation of the United Nations: <http://www.fao.org/save-food/resources/keyfindings/en/>
- Food Panda. (2019, April 29). *Food Panda*. Retrieved from Food Panda Foodora: <https://www.foodora.com/>
- Gadde, L.-E., & Amani, P. (2016). Food supply in a network context: An alternative framing and managerial consequences in efforts to prevent food waste. *British Food Journal*, Vol. 118 Issue: 6, <https://doi.org/10.1108/BFJ-10-2015-0401>, 1407-1421.
- Gould, G. W. (1996). Methods for preservation and extension of shelf life. *International Journal of Food Microbiology*, 51-64.

- Hakansson, H., & Snehota, I. (1995). *Developing Relationships in Business Networks*. London and Newyork: Routledge.
- Heitkötter, H., Hanschke, S., & Majchrzak, T. A. (2013). Evaluating Cross-Platform Development Approach for Mobile Development. *Web Information Systems and Technologies, 8th International Conference* (pp. 1-20). Porto, Portugal: Springer Berlin Heidelberg.
- Jumia. (2019, April 29). *Jumia Food*. Retrieved from Jumia Food Kenya: <https://food.jumia.co.ke/>
- Kasim, A. (2007). Towards a Wider Adoption of Environmental Responsibility in the Hotel Sector. *International Journal of Hospitality & Tourism Administration*, 25-49.
- Kenya Association of Hotel-Keepers and Caterers. (2019, April 29). *KAHC Members Directory*. Retrieved from Kenya Association of Hotel-Keepers and Caterers: <http://kahc.co.ke/kahc-members-directory.php>
- Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., & Searchinger, T. (2013, June). Reducing food loss and waste. *Installment 2 of "Creating a Sustainable Food Future"* by World Resources Institute, pp. 1-33.
- Munro, H., Miroso, M., Mangan-Walker, E., & Pearson, D. (2016). Reducing waste of food left on plates: Interventions based on means-end chain analysis of customers in foodservice sector. *British Food Journal*, 2326 - 2343.
- Obi, L. (2017, May 14). A third of the world's food goes to waste after harvest. Nairobi, Kenya. Retrieved from <https://www.nation.co.ke/lifestyle/dn2/world-s-food-goes-to-waste-after-harvest/957860-3927024-15gw5nw/index.html>
- OMG. (2007). Specification. *A UML Profile for MARTE, Beta 1*.

- Othman, R., & Abdul-Ghani, R. (2008). Supply chain management and suppliers' HRM practice. *Supply chain management and suppliers' HRM practice*, 259-262 .
- Ottka, S. (2015). *Comparison of mobile application development tools for multi-platform industrial applications*. Masters Thesis, Aalto University, School of Science, Espoo. Retrieved April 29, 2019, from https://aaltodoc.aalto.fi/bitstream/handle/123456789/16008/master_Ottka_Sanna_2015.pdf?sequence=1
- Parfitt, J., Barthel, M., & Macnaughton, S. (2010, September 27). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*.
- Pirani, S., & Arafat, H. A. (2015). Reduction of Food Waste Generation in the Hospitality. *Journal of Cleaner Production*, 129 - 145.
- Principato, L., Secondi, L., & Pratesi, C. A. (2015). Reducing food waste: an investigation on the behaviour of Italian youths. *BRITISH FOOD JOURNAL*, 731-748.
- Rescuing Leftover Cuisine. (2019, April 29). *Rescuing Leftover Cuisine*. Retrieved from Rescuing Leftover Cuisine: <https://www.rescuingleftovercuisine.org/>
- Resource Efficient Scotland; Natural Scotland; Catering Equipment Suppliers Association. (2012). *Managing Food Waste in the Hospitality and Food Service Industry*. London: Resource Efficient Scotland.
- Snehota, I. (2011). New business formation in business networks. *The IMP Journal*, 1-9.
- Stop Wasting Food Movement. (2019, April 29). *Food Waste Facts*. Retrieved from Stop Wasting Food Movement: <http://stopwastingfoodmovement.org/food-waste/food-waste-facts/>

Todorova, V. (2013, July 8). Safe to eat leftovers served to most needy across Abu Dhabi. Abu Dhabi, UAE. Retrieved from <https://www.thenational.ae/uae/safe-to-eat-leftovers-served-to-most-needy-across-abu-dhabi-1.338188>

Ventour, L. (2018). *The food we waste* . Banbury: Material Change for Better Environment.



Appendices

Appendix A: Use Case Diagrams

Appendix A.1 shows the view meals available use case description.

Appendix A.1: View Meals Available Use Case Table

Use case name	View meals available
Description:	Customers can view the meals available in the various restaurants/ hotels
Primary Actors:	Customer
Precondition:	Customer must be logged in and the meals table should have data.
Post condition:	Customer must select a hotel
Typical case of Events Actor Response 1. Select a restaurant to view the meals.	System Response 1. Show all the meals available in that restaurant.

Appendix A.2 shows the user description for ordering a meal.

Appendix A.2: Order Meals Use Case Table

Use case name	Order a meal
Description:	Customers can order a meal
Primary Actors:	Customer
Precondition:	Customer must be logged in and select a restaurant.
Post condition:	Customer must place meals on a cart
Typical case of Events Actor Response	System Response 1. Customer gets a notification that the order has been placed.

1. Selects meals to take and places on a cart to place an order	2. Application prompts for payment details.
---	---

Appendix A.3 shows the use case description for editing meal details.

Appendix A.3: Edit Meals Details Use Case Table

Use case name	Edit meal details
Description:	The admin and restaurant contact persons can edit the meal details.
Primary Actors:	Admin, restaurant
Precondition:	Admin/restaurant must be logged in
Post condition:	The meal table in the database is updated.
Typical case of Events Actor Response 1. Selects a meal to edit and puts amends to it.	System Response 1. User gets a confirmation message that the update has been effected.

Appendix A.4 shows the use case description for viewing reports.

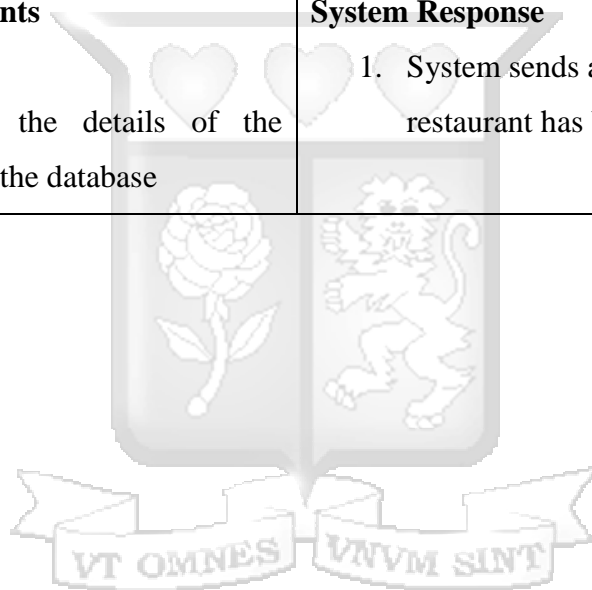
Appendix A.4: View Reports Use Case Table

Use case name	View reports
Description:	Restaurants can view reports on the meals and orders made.
Primary Actors:	Admin, restaurant admin
Precondition:	Users must be logged in
Post condition:	Users are able to view the reports of the meals and orders by restaurant
Typical case of Events Actor Response 1. Logging to the dashboard of the backend	System Response 1. Shows all reports by restaurant

Appendix A.5 shows the use case description for creating restaurant profiles.

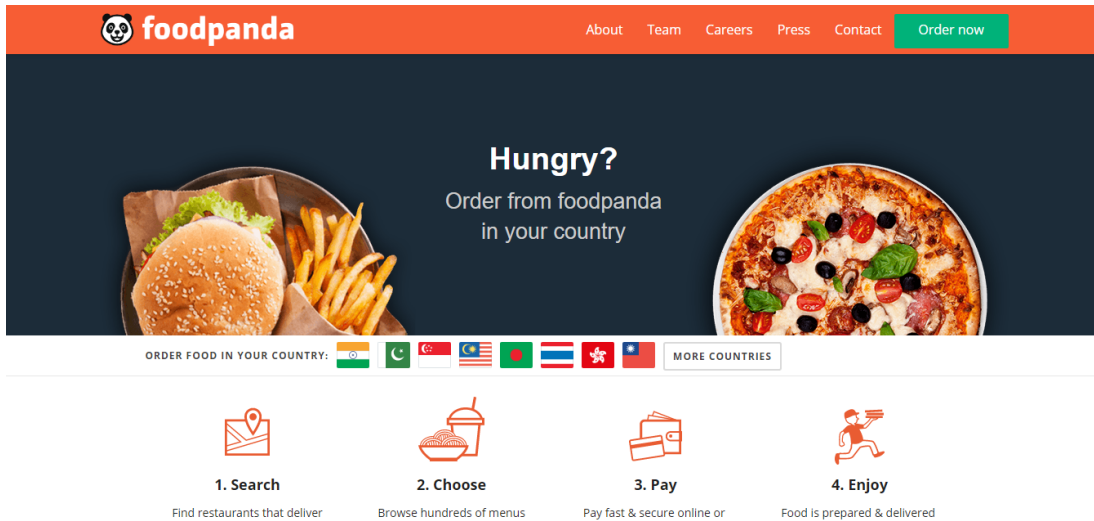
Appendix A.5: Create Restaurants Profiles Use Case Table

Use case name	Create restaurant profiles
Description:	Admin can create restaurant profiles so that they are able to share meals on the application.
Primary Actors:	admin
Precondition:	Must be logged in
Post condition:	Restaurants table is updated
Typical case of Events Actor Response 1. Admin add the details of the restaurant to the database	System Response 1. System sends a notification that the restaurant has been added.



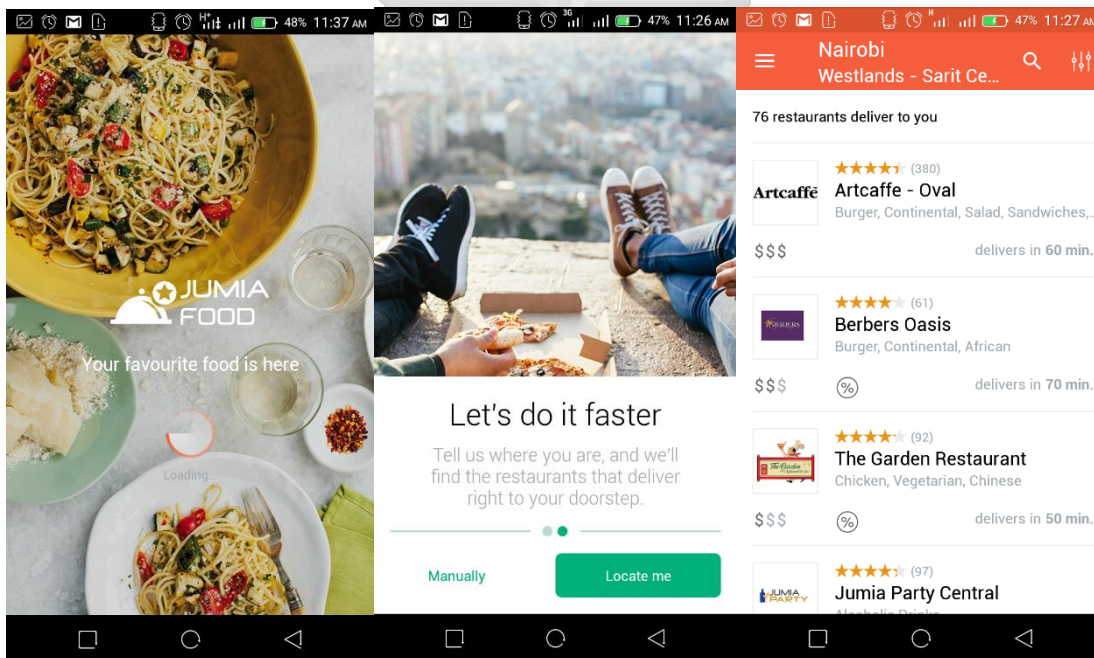
Appendix B: Screenshots of Existing Solutions

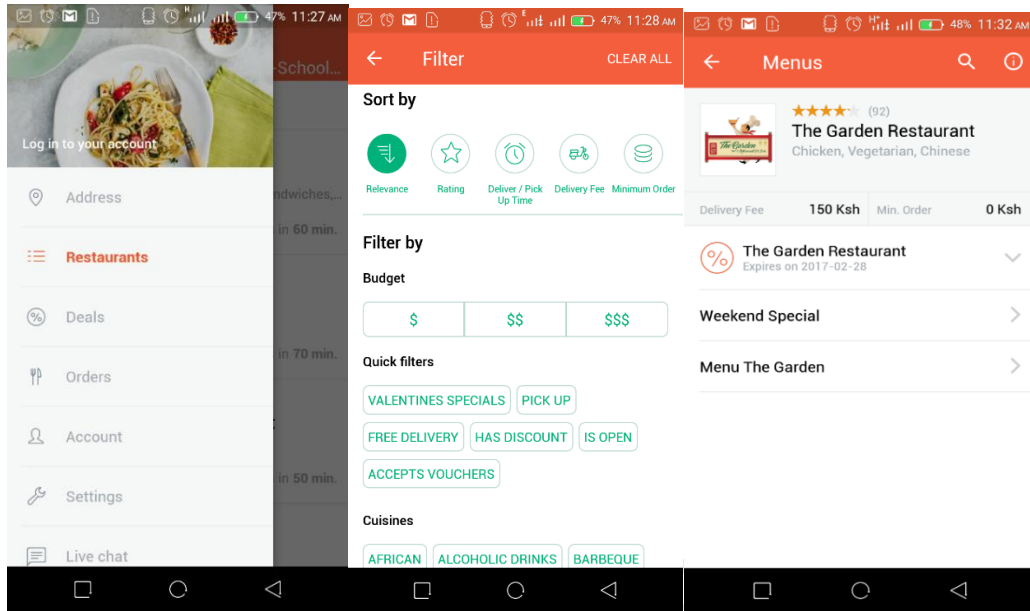
The screenshots below are of a mobile application, Food Panda, that allows users to make orders for freshly prepared food on the application and have it delivered to the customer's doorstep.



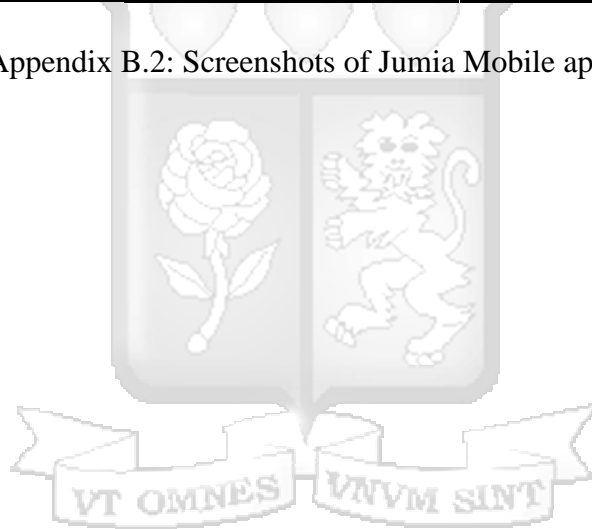
Appendix B.1: Screenshot of the FoodPanda Web Application

The screenshots below are of an application used largely in Kenya named Jumia Food. Through the application, users can order for freshly prepared food from the application and track it being delivered.



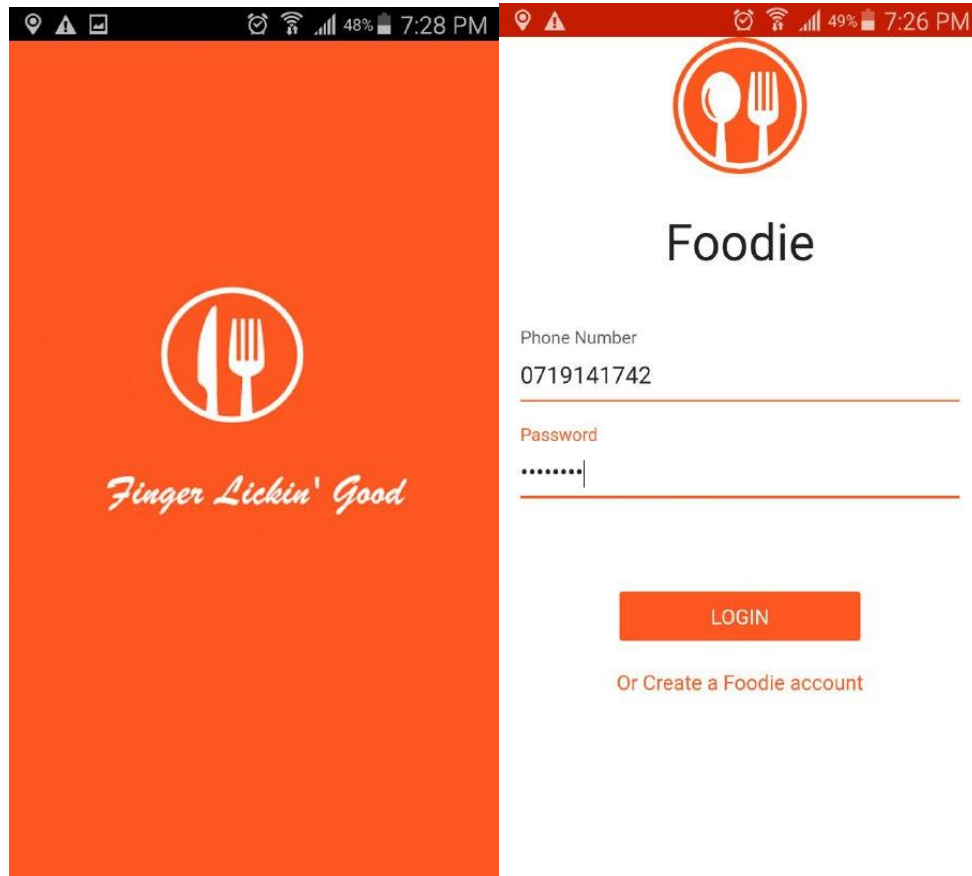


Appendix B.2: Screenshots of Jumia Mobile application



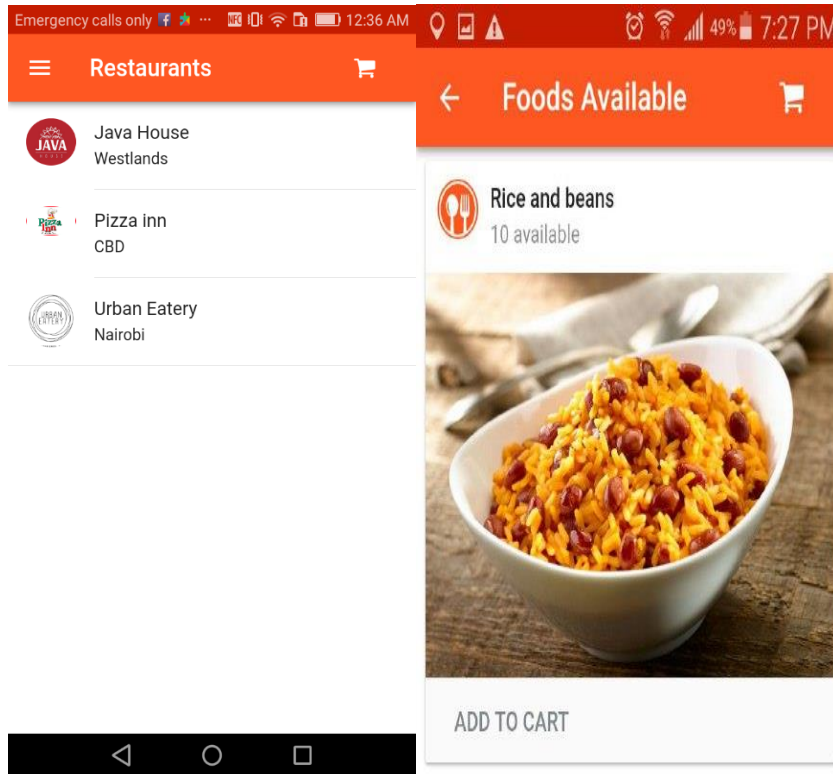
Appendix C: Screenshots *Foodie* Application

The screenshot below is of Foodie app, and it illustrated the splash screen and the login pages of the application.



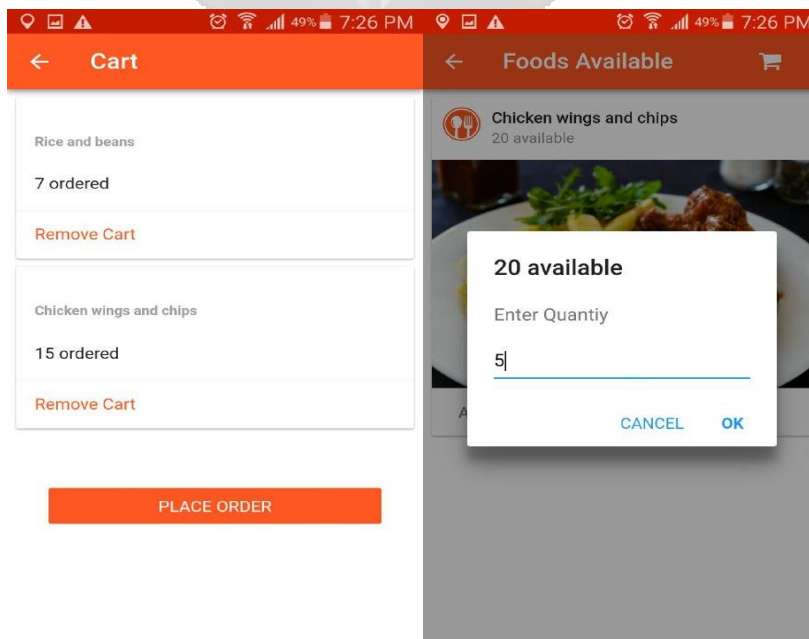
Appendix C.1: Splash screen and Login screen

The screen shot below of the Foodie application show how a user is able to view a list of all the listed restaurants and can choose the restaurant they wish to place an order with.



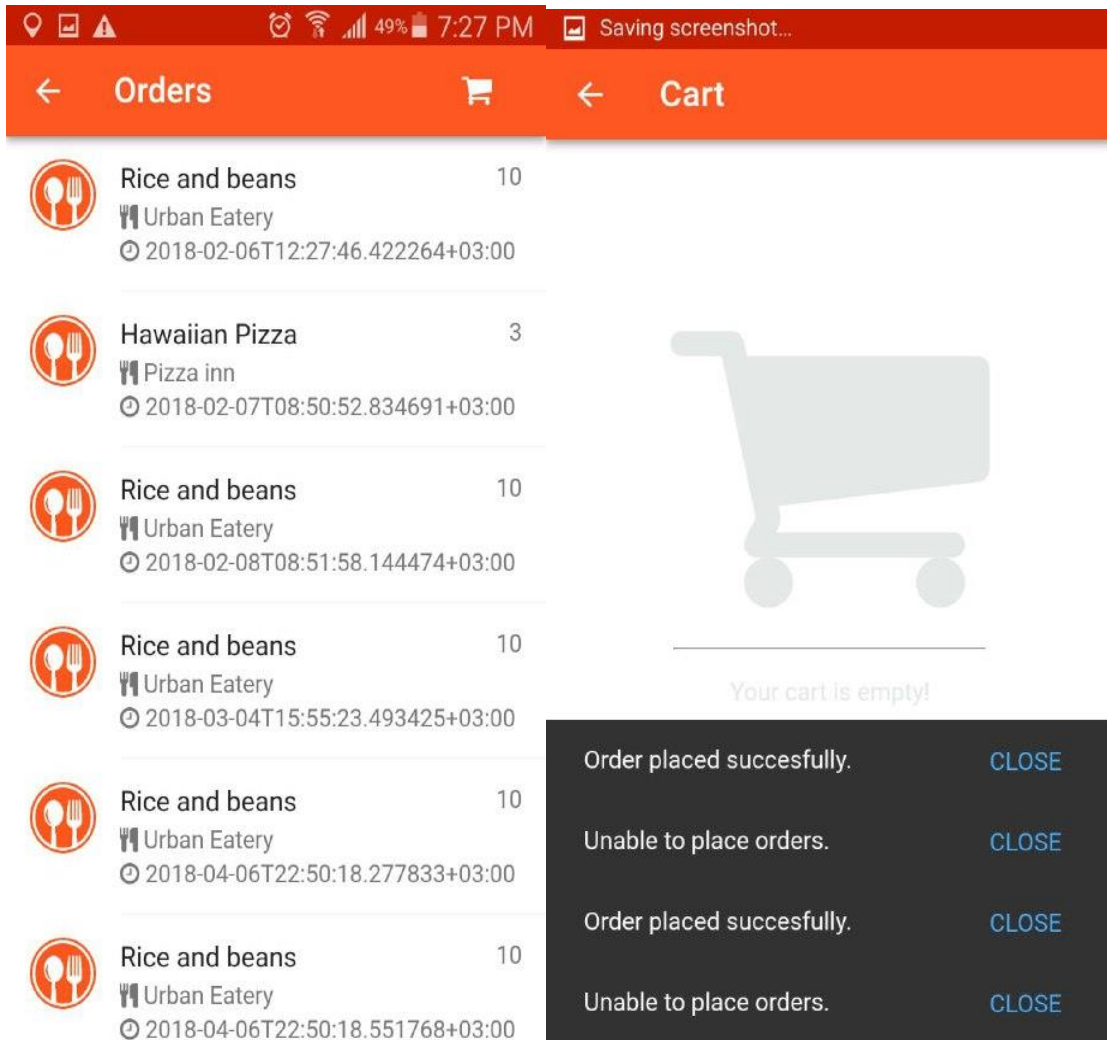
Appendix C.2: Restaurant and meal available

The screenshot below shows the process of placing the food you wish to get on a cart for ordering.



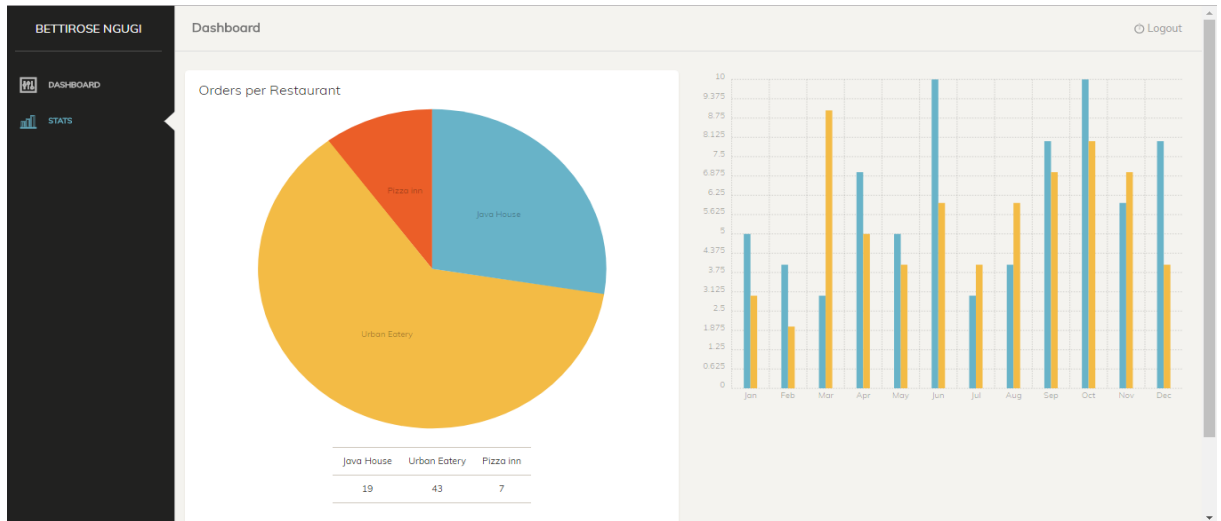
Appendix C.3: Placing an order on the application

The screenshot below shows the orders one has placed and the cart that is currently empty.

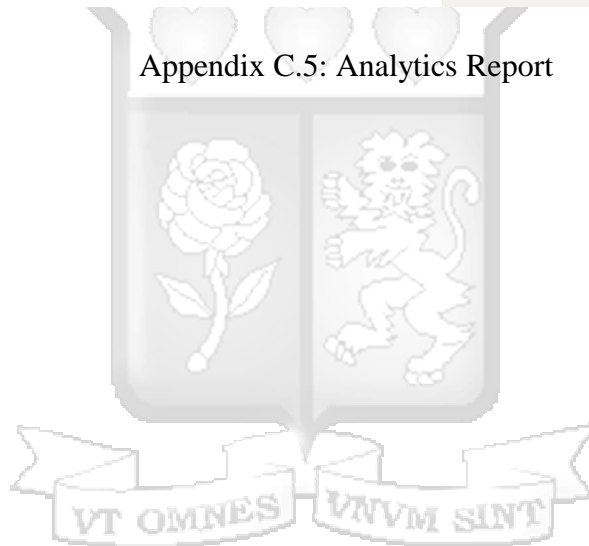


Appendix C.4: Viewing orders and adding to orders to a cart

The screenshot below shows the analytics done on the back end of the system.



Appendix C.5: Analytics Report



Appendix D: Questionnaire

Dear Respondent,

I am a Masters student in the Faculty of Information Technology, Strathmore University conducting a research entitled “a mobile application that helps manage food wastage problem in the hospitality industry in Nairobi”

You have been selected to form part of this study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidence.

Kind Regards,
Bettirose Ngugi.

* Required Fields

SECTION A: BACKGROUND INFORMATION

1. What is your gender? * Mark only one oval.

- Male
 Female

2. What is your age group? * Mark only one oval.

- 13-17
 18-24
 25-34
 35-54
 55+

3. What is your relationship status? *
Mark only one oval.

- Married
- Single
- Dating

4. What is your occupation? * Mark only one oval.

- Employed
- Student
- None

SECTION B: Food Waste

5. Have you experienced food waste?

* Mark only one oval.

- YES
- NO

6. If YES, where?

Mark only one oval.

- At home
- Restaurant
- Event e.g. wedding
- School Cafeteria



7. Was the food that went to waste human consumable?

Mark only one oval.

- Yes
- No

8. Would be comfortable ordering left over food from restaurants that is still high quality and human consumable?

Mark only one oval.

Yes

No



Appendix E: Usability Testing and Validation Questionnaire

Section A: Usability Testing

A1. How do you find the user interface of the mobile application based on its look and feel? (Choose ONE)

- Attractive
- Average
- Not Attractive

A2. Rate the mobile application based on whether the application was easy to learn and use as a first time user? (Choose ONE)

- Good
- Fair
- Bad

A3. Rate the system functionality based on whether it met the user requirements? (Choose ONE)

- Yes
- No

A4. Would you use the mobile application in ordering left over food from restaurants? (Choose ONE)

- Yes
- No

Section B: Validation Testing

B1. Do the functionalities provided by the application solve the food waste problem? (Choose ONE) *

- Yes
- No

B2. Are you satisfied with solution provided by the application as far as capturing left over food from restaurant and put it up for sale at discounted rates is concerned? (Choose ONE)*

- Yes
- No

B3. Would you recommend other people to use the application? (Choose ONE)*

- Yes
- No



Appendix F: Turn it in results

feedback studio Bettirose Ngugi Njoki Bettirose Dissertation

A MOBILE APPLICATION THAT HELPS MANAGE FOOD WASTAGE PROBLEM IN THE HOSPITALITY INDUSTRY IN NAIROBI

BETTIROSE NJOKI NGUGI
STUDENT NO: 091460

A dissertation submitted in partial fulfillment of the requirements for the Master of Science Mobile Telecommunications and Innovation at

Page: 1 of 70 Word Count: 13091

Match Overview

29%

1	Lars-Erik Gadde, Pegah... Publication	9%
2	Submitted to Strathmor... Student Paper	5%
3	researchspace.csir.co.za Internet Source	2%
4	www.rescuingleftoverc... Internet Source	1%
5	Heitkötter, Henning, Se... Publication	1%
6	Submitted to Universiti ... Student Paper	<1%
7	wikivisually.com Internet Source	<1%

Text-only Report

Appendix F.1: Turn it in results

