Integrated Information System for a Food Processing Industry: Case Study of Cashew Nuts Processing

A Thesis Presented to the Department of Computer Science

African University of Science and Technology

In Partial Fulfilment of the Requirements for the degree of

Master of Science in Computer Science

By

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Abuja, Nigeria

July 2021

CERTIFICATION

This is to certify that the thesis titled “Integrated Information System for a Food Processing Industry: Case Study of Cashew Nuts Processing” submitted to the school of postgraduate studies, African University of Science and Technology (AUST), Abuja, Nigeria for the award of the Master's degree is a record of original research carried out by Margaret Ekanem Udoh in the Department of Computer Science.

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ABSTRACT

Information System (IS) is an integrated set of components for collecting, storing, and processing data and for providing information and knowledge. IS is commonly used by organizations, business firms, institutions to manage their operations, goods, supply chains, financial accounts, customer interaction amongst others. Information System is a major aspect of any business organization. A poorly designed and managed IS can cost a lot to any business. Hence, proper integrated IS should be at core of an organization. Cashew tree (Anacardium occidentale) is a tropical tree that produces cashew apple and cashew seeds. It has been cultivated for food and medicine for over 400 years. Cashew is a natural crop in Nigeria, grown in about 19 states with an annual average production increase of 5% and expected to produce 300,000 metric tonnes of cashew by 2030 (Nigerian Export Promotion Council - NEPC, 2020). With such large quantity of cashew production annually, a well-designed information system is needed to manage the financial accounts, supply chain and consumer of the company. This project aims to provide an integrated information system for cashew nut processing in Nigeria. This will greatly avert cashew losses, save cost of exporting cashew and importing cashew nut, generate employment and help generate revenue in Nigeria. Entity relationship models and data warehouse models are used in the information system. Drupal 9, Symfony and Doctrine are software tools used in web application and database development of the information system.

Keywords: Information System, Data warehouse, Symfony, Drupal, Entity Relationship model, cashew nut processing.

DEDICATION

This thesis is dedicated to God almighty, for seeing me through my master's program and to my husband, Mr Daniel Egan for your unending support and motivation throughout this program.

ACKNOWLEDGEMENT

I thank God for His Grace to complete my Master's program.

I appreciate my loving husband Mr Daniel Egan, for always supporting and encouraging me during this program.

I appreciate my son, Simon Egan, my parents Dr. & Mrs Ekanem Udoh, Mrs Glory Egan, my siblings, Engr. & Mrs Eya and all my family members, for believing in me and assisting me always to ensure the program is a success.

I appreciate my supervisor Prof Amos David, always being there to guide me in this research.

My appreciation also goes to HOD Computer Science department, Dr Rajesh Prasad, my course mates, all staff and students of AUST.

My sincere gratitude to African University of Science and Technology (AUST) for the scholarship opportunity.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CMS	–	Content Management System
CRM	–	Customer Relationship Management
EDW	–	Enterprise Data warehouse
ERD	–	Entity Relationship Diagram
ERM	–	Entity Relationship Model
IIS	–	Integrated Information System
IS	–	Information System
RM	–	Relational Model

CHAPTER ONE: INTRODUCTION

1.1. Introduction to the Study

Integrated Information System (IIS) is an information management system that uses latest technology to cover all aspects of an organizations business to ensure the organization has competitive edge and achieve its set goals.

IIS can also be defined as a combination of software that gets information from different databases from different sources with models, data integration tools and visualization (MOHAMED et al., 2013). Data is typically deployed across a number of different, frequently autonomous information systems, and data communication between them must be carefully planned.

In our case study: Cashew Nuts processing, the use of integrated information system will enable us make proper decision on the type of data needed by each aspect management of the cashew nut processing enterprise. We will be able to properly connect the business model and technology, as well as ensuring that data isn't omitted or overlooked, and that it is saved appropriately with the appropriate metadata. Figure 1.1 shows the advantages of information system in an organization.

Figure 1.1: Advantages of information system

1.2. Research Background

With the advancement of technology and existence of diverse mobile devices, information has become ubiquitous. As a result, proper information processing, management, and usage have become a major concern. Agriculture, like every other field, needs the information gotten from all its stages such as planting, grooming, harvesting, sales, financial record etc. to be properly managed.

Cashew nut processing involves numerous phases – roasting, shelling drying, peeling, grading, quality controls and packaging – and data gotten from these phases are to be used appropriately for better management of cashew nut processing business. Cashew is a source of income, food and raw materials for cashew producing countries. In Nigeria, over one million people depend on cashew industry and current cashew trading and exports is worth $160 million. From 1965 to 1990 cashew production was relatively static at 25,000 tonnes with estimated land area of 50,000 ha in 1990. As at 2017, cashew annual production in Nigeria exceeds 340,000 metric tonnes (Kolliesuah *et al.*, 2020).

With the use of data models, data modelling software, DBMS (MySql), Drupal and Symfony we are able to develop an integrated information system for cashew nut processing.

1.3. Problem Statement

"Information management is to make sure that the right information is shared with the right persons at the right time in the right place." (Zhu, 2017). A major challenge in the society today is that information isn't stored properly to make it efficient, easily accessible and reliable.

Some organizations keep records of irrelevant information which takes up storage space, some information is not in the right format which makes it difficult to edit and some very important information are neglected because decision makers of the system aren't consulted (Pastor, 2020).

This project aims to eradicate these issues in cashew nut processing and ensure an efficient integrated information management system.

1.4. Aims and Objectives

The aim of this research is to develop an information management system for cashew processing. A case study of cashew processing in Nigeria.

The main objectives are:

1. To develop a Drupal and Symfony application used for information management.
2. To discover ways of processing information associated with cashew processing.
3. To take into consideration data based on decision makers.
4. To avoid storage of irrelevant data in the information system

1.5. Project Scope

The scope of this project is to develop an integrated information system for cashew nut processing using Drupal 9 and Symfony to access external database. It also includes decision making on the data required based on primary users of the system and developing an entity-relationship data model that represents the information to be managed.

CHAPTER 2: LITERATURE REVIEW

2.1. Decision Making

Harold Koontz defined decision making as the selection of a course of action among alternative (Aayat, 2019). Decision making is the first phase in the development of a system. In developing an information system, the key stakeholders that will make use of the system are the decision makers. The decision making process begins before data acquisition in the development of an information system (Travica, 2013). The system developer needs to know from each stakeholder the specific data required. This step helps achieve the following:

1. Avoid getting data that is not relevant in the system
2. Avoid neglecting data
3. Help in design proper data model
4. Avoid repeating the data collection stage
5. Saves time and avoid delays in system development
6. Avoid inconsistencies between different stakeholders of the same system

2.2. Data Models

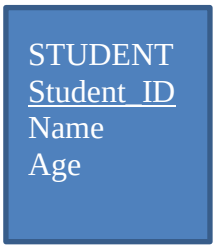
2.2.1. Entity Relationship Model

Entity Relationship Model (ERM) is a conceptual data model that represents the entities, data and associations of objects to be managed in an organization (Entity Relationship Model, n.d.). It is majorly concerned with what is represented in the database and not how the model is implemented. ERM models a business data schema in graphical form; it doesn't represent the business processes. It models the data as conceptual schema for database. It aids in the systematic analysis of data requirements in order to create a well-designed database. ERM uses a diagram called an Entity Relationship Diagram (ERD) to illustrate the structure of a database (Singh, 2021). ERD shows the relationship between entity sets in a database and explains the logical structure of database (Rungta, 2021).

ERD was developed by Peter Chen in 1971 with the aim to design a uniform standard that may be used in relational databases. The 4 basic concepts of ERD are:

1. Entity: An entity is a real-world object that has its own existence and can be distinguished from other objects. Example: a student, a car, a job. An entity should be identifiable, has real existence and the instances have the same characteristics. In an ERD, an entity is represented by a name in a rectangle (What Is Entity Relationship Diagram (ERD)?, 2021).

2. Attribute: An attribute is a property of an entity. An entity can have more than one attribute. Each attribute has a domain that defines the range of values that can be assigned to it. Attributes are determined based on the project and the result from the decision making process. One of the attributes of an entity should have a unique value for each entity, called an identifier. Attributes are listed below the entity name in ERD with the identifier underlined.



3. Relationship: A relationship is an association between entities. It is represented by oval shape in ERD. Sometimes a relation has an attribute and the attribute is a characteristic of the relation and not the entities.

4. Cardinality: Cardinality refers to the relationship between the number of occurrences in one entity and the number of occurrences in another. The maximum number of entities of one type that can be linked to another type of entity. Example: One class has many students; in the ERD, entities class and students have a one-to-many relationship. Cardinalities are represented as
   a. (1,1)
   b. (1,m)

2.2.2. Relation Model

A relation is simply table of values. The relational model (RM) for database management is a data management model in which all data is represented as tuples that are grouped into relations. A relational database is one that is organized using the relational model. The table format is used to save the relations. Records are represented by rows while attributes are represented by columns.

Some concepts in relational model:

a. Tuple: a tuple is a single row of a table, which contains a single record for that relation.
b. Relation key: Each row comprises of one or more attributes which can be used to uniquely identify the row in the relation and this unique attribute is called relation key.
c. Domain: Every attribute has a pre-defined value scope, which is referred to as the attribute domain.

Relational Integrity Constraints

a. Key constraints: At least one minimal subset of attributes in the relation must be able to uniquely identify a tuple. This minimal set of attributes is referred to as the key for that relationship. For key attributes, no two tuples can have the same values. There can’t be any NULL values in a key attribute because null values can be used as a key value in more than one relation, which violates the constraint that a key attribute must be unique.

b. Domain constraints: Attributes are to be from a specific domain to maintain data integrity. Example: Domain of age can be 0 to 150. We don't expect age to be less than 0, this constraint has to be enforced to avoid wrong data input.

2.3. Cashew Processing

Cashew (Anacardium occidentale L); a tropical tree, is an evergreen tree that produces cashew seed and cashew apple. It grows as high as 14meters, with large canopies. There are also small to medium size cashew trees with height of about 6meters which have earlier maturity, greater yields and proof to be more profitable. This small sized cashew trees is our focus for the production of cashew nuts in large quantity.

Cashew cultivation began in Nigeria in 1950. In 1972, Cocoa Research Institute of Nigeria began research into the cultivation, economic benefits and uses of cashew in Nigeria (Adeigbe et al., 2015). Cashew grows on about 325,000 hectares in Nigeria in almost all ecological zones. Nigeria is among the world's producers and exporters of cashew (FAOSTAT, n.d.). The drought resistant tree is economically grown for its apple, nuts and wood. An annual growth of 54% in export value of raw cashew nuts (RCN) was reached during 2013-2017 (Nigerian Export Promotion Council - NEPC, 2020).

Cashew nut, a processed nut from cashew fruit, is a healthy nut produced from drying, deshelling and peeling raw cashew nuts. It is rich in protein and healthy fats. It is currently among the one of the most valuable processed nuts in global commodity markets, with a market value of 6.27 billion US dollars. Some of the uses of cashew tree include mitigating soil erosion because of their extensive root system; it also serves as a natural umbrella because of the trees expansive horizontal branch system.

About 5% of produced cashew nuts are processed in Nigeria (Nigerian Export Promotion Council - NEPC, 2020). There is need for increase in cashew nut processing in Nigeria. This can be improved with establishment of more cashew processing industries in Nigeria. With the use of adequate information system by cashew processing industries, relevant data and processing information can be stored.

Cashew nut processing traditional method involves these stages: roasting, shelling, drying, peeling, grading, quality controls, fumigation and packaging. Figure 2.1 shows the steps of cashew processing to edible cashew nut. Automation of the process can be achieved and this primarily begins with the use of information system. During each phase, necessary information is gathered like duration of the process, materials needed, quantity of cashew processed at a time etc. With this information and system development an automated cashew processing system can be produced.

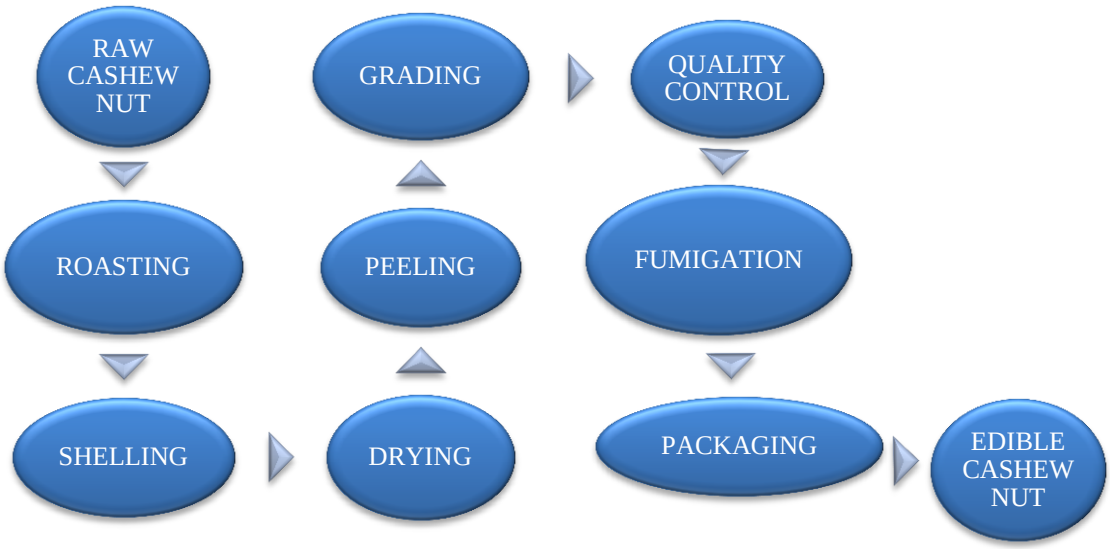


Figure 2.1: Stages of Cashew Nut Processing

2.4. Information System in Agriculture

With the advancement of technology, digitalization and ICT; information system is being used in various fields including agriculture. IS used in agriculture can be used in various phases; planting, seed modification, securing farms and crops through insurance systems, remote monitoring, capacity building and training of farmers, digital payments, prediction of climate change to limit negative impacts, increase market information availability etc.

There are several digital system developed for use in agriculture.

1. SAP Rural Sourcing Management: is a system designed to assist smallholder farmers in developing nations in connecting with global producers. It ensures financial transparency, accountability, and accessibility. It is a cutting-edge mobile application for small-scale farmers' digital inclusion. This system is currently in use in Uganda ("Innovation and Technologies in the Cashew Sector, 2019").

2. Securing Sustainable Supply software system (3S): this is a software system developed by ComCashew in collaboration with the Sustainable Nut Initiative (SNI) focuses on the cashew value chain. Its aim is to increase transparency in order to ensure supply security, improve quality, and work for long-term sustainability. It allows exchange of data between links in the cashew supply chain.

3. ACA Market Information System: is designed to give market trend information in cashew-producing countries. An online database is used to disseminate seasonal updates on production, raw cashew nuts, and kernel prices.

The systems highlighted above deals with different phases of agriculture; cashew in particular. The proposed information system being developed will specifically carter for the information regarding supply and sales of processed cashew nut.

2.5. Software Engineering Tools

2.5.1. Symfony

Symfony is a set of reusable PHP components and a PHP framework for web projects. Symfony can also be seen as an open source distributed PHP framework. Symfony components are a collection of decoupled and reusable components on which the best PHP applications such as Drupal are built (Laaziri et al., 2019).

Symfony framework is the leading PHP framework for developing websites and web applications. It is built based on Symfony components. The framework helps to make sure that you're creating an application that is well-structured, follows all business rules, it is maintainable and upgradeable.

Some of the benefits of using Symfony are

a. Limitless flexibility
b. Sustainable
c. Ease of use because it is easily accessible and flexible
d. Fast; it is fastest PHP framework.
e. Integrated security features

2.5.2. Drupal (Version 9)

Drupal is a content management system (CMS) used to create, maintain, and manage websites and their contents. It is an open source CMS and runs mainly from contributions of developers from several developers. Modules can be developed and added to a website to increase functionality of existing product. Drupal is scalable; it integrates other systems such as marketing tools, Chabot, customer relationship management (CRM) tools and lots more. The Drupal community had more than 1.39 million members as of March 2021(Drupal Association, 2021). It has an easy-to-use interface compared to other CMS.

Drupal 9 is the latest version of Drupal released on June 3 2020. It has a main feature of data abstraction and includes the ability to run on the Windows web server IIS. Drupal 9 improves the data abstraction layer, removing the requirement for programmers to write SQL queries as text strings. The database is abstracted using PHP Data Objects. Due to the database abstraction of Drupal 9, symfony framework is needed in web application development as this provides access to external database.

CHAPTER 3: METHODOLOGY

3.1. Design of Entity Relationship Model

Design of Entity Relationship Model (ERM) is a major phase in the development of an integrated information system. The task involved in this stage include

1. Decision Making: The stakeholders of the cashew nut processing organization were interviewed to know their data needs and expectations from the system. This enables us make proper decision on the data to be included, the format the data should be stored, access restriction and avoid storing data that isn't needed in the system.
    a. Chief Executive Officer: The CEO needs access to retrieve every information in the system but would not make modifications on them. Any modification needed will be done by the head of department directly involved with the information.
    b. Finance Head of Department: the head of department (HOD) needs access to the income (sales) and expenditure (Salary, maintenance, purchases, insurance) of the organization. The HOD can view the income being recorded by the sales department and for every expenditure authorized; the financial recorded is modified.
    c. Suppliers: The suppliers supply raw cashew to the organization for processing. The data needed from them include company name, address, phone number, contact person.
    d. Customers: These are individuals or companies that purchased the processed cashew nut. Their data are only collected at the point of payment for purchase. The information needed are name, phone number, address, receipt id. The customers provide and can view the data but do not modify.
    e. Human Resource: The head of department (HOD) handles information about staff such as promotion; can monitor the suppliers by modification of supplier's data and use record from customers to give discount to regular customers. The HOD can modify the staff and customers record.

f. Staff: each staff has the following data: name, address, phone number, age, position, salary, date of appointment. Each staff can view the data but modification is done only through the human resource department.

g. Sales: the head of sales department (HOD) keeps record of items purchased and amount purchased. Using the information system to keep records of cashew nut purchased enables quick and easy access to information of cashew nut left in stock. This helps avoid running out of stock.

2. Design of ERM

Entity Relation Model gives a full breakdown of entities and their attributes that will be used in the development of the database. Table 3.1 represents the entity relational model of the system. The attributes bolded represent the identifier of the entity.

Table 3.1: Entity Relationship Model

Entities	Attributes
Staff	**Staff ID**, Name, Address, Telephone number, Marital Status, Position, Salary
Supplier	**Supplier ID**, Company name, Address, Telephone number, Product Supplied
Customer	**Customer ID**, Name, Address, Telephone number
Product	**Product ID**, product name, Supplier ID, category, Price

3. Design of Data warehouse

Data warehouse is a central collection of integrated data from multiple sources. It is also known as Enterprise Data warehouse (EDW) and is used for data analysis and reporting. The entity relation model above was adapted for data warehousing by identifying the attributes whose values can change over time and make them entities. Example: a staff position can change over time hence position becomes an entity and 'act of change of position' entity is created to keep record of the date of change. We also created an association between the new entity and the old one and added the time when change occurred. Table 3.2 shows the data warehouse of the system.

Table 3.2: Data Warehouse

ENTITIES	**ATTRIBUTES**
Staff	Staff ID, Name, Telephone number
Supplier	Supplier ID, Company name, Telephone number, Product Supplied
Customer	Customer ID, Name, Telephone number, Receipt ID
Product	Product ID, product name, Supplier ID, category, Price
Address	Address ID, Address
Position	Position ID, Job title
Marital Status	Status ID, Status
Salary	ID, Amount
Act of change of MS	AC ID, date of change
Act of change of salary	AC ID, date of change
Act of change of Position	AC ID, date of change

4. Design of Entity Relation Diagram (ERD)

The ERD was designed using ‘looping’ software. Looping is a software used to design entity relation diagrams, convert ERD to the logical model, and physical model of the database. Figure 3.1 is the entity relation diagram designed.

These rules were considered when designing the ERD

1. Structured attributes were decomposed. The decomposed attributes became entities. Eg. Address of the company was decomposed to AddressID (house number, street name), Town, LGA and state. Decomposing structured attributes helps in retrieving and modification of information.
2. Attributes which can have more than value should be made an entity.
   E.g. Telephone number; an individual can have more than 1 telephone number so it is made an entity.
3. Ensure data integrity by identifying functional dependencies between attributes
4. Relations between attributes are added to the ERD. Some relations have attributes that describes the relation.
5. The cardinalities between entities are considered and the maximum cardinalities on either side of the relation are written above the relation.

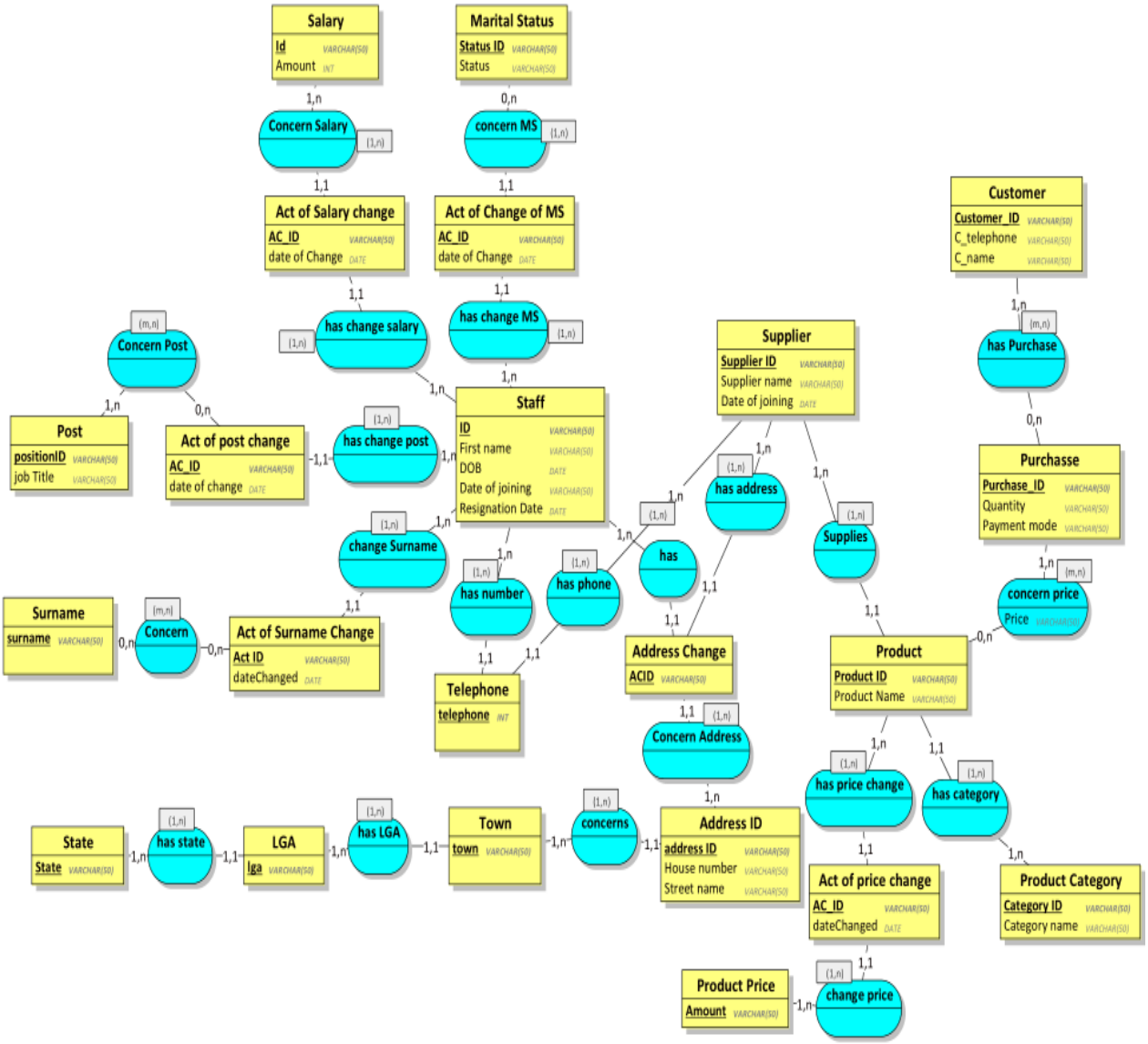


Figure 3.1: Entity Relationship Diagram

3.2. Conversion of Entity Relationship Model to Relational Model

With the use of Looping software, the entity relational model presented in the previous section is represented as relational model through the following steps. In Figure 3.2, we see the relational model of the system.

1. Each entity corresponds to a relation
2. Each attribute of an entity corresponds to an attribute of the relation
3. The identifier of an entity becomes the key of the relation
4. Add the key of the relation on the n side to the key of the relation on the 1 side for associations of maximum cardinality [1:n].
5. For associations with maximum cardinality [n:m], a new relation should be established with the concatenation of the associated relations' keys as the key. The association's attributes should be added to the new relation's attributes.

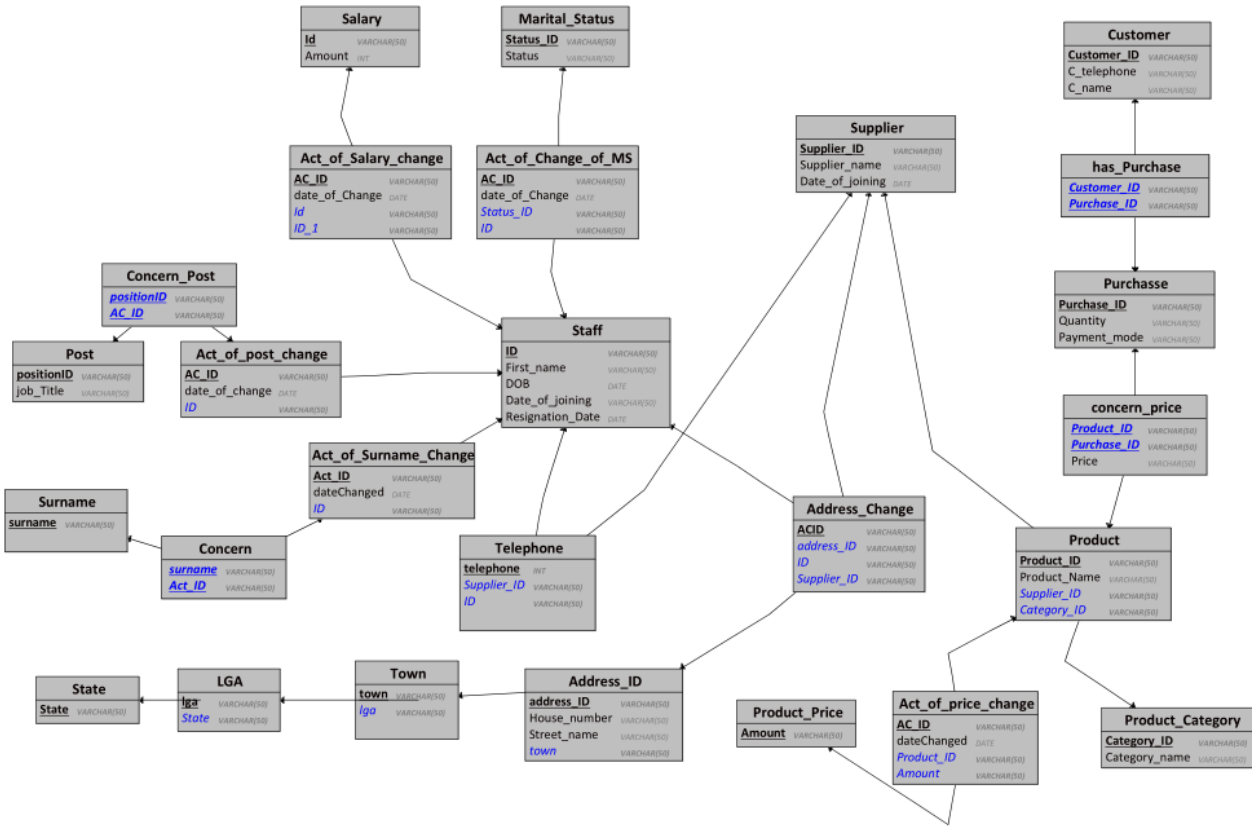


Figure 3.2: Relational Model

CHAPTER 4: IMPLEMENTATION AND RESULT

4.1. Implementation

After the design stage of the information system, the implementation of system was done in these phases:

1. Webhosting

   A web host (sometimes known as web hosting service) is an internet service that enables individuals and businesses to make their websites available via the World Wide Web. 'Whogohost' web host was used and domain name 'capte.ng' was purchased. With the web host, the project was allocated space on web server to store files and data. Cpanel is a web hosting control panel software used.

2. Create Web Application

   With the webhost service and domain name available, a web application was developed using Drupal Content Management System (CMS). After successful installation of Drupal, the CMS provides an avenue to setup the web application. This task is done through the administrator platform and access is restricted to the administrator of the application.

3. Develop the database

   The database was created in a relational database management system – MySql. Structured Query Language (SQL) is the query language used to store, access and modify the database. The attribute of a relation are columns of the table and instances of the relation are the rows of the table. When developing the database, we ensure data integrity by specifying the type of value that can be stored in an attribute. Example a staff name cannot contain numbers. Appendix A shows the SQL used to create the database.

4. Access control of the system

   Drupal has strong security features which include access control. Access control to the system is regulated with the use of roles. We created roles in Drupal CMS using this feature and the roles gotten from the decision making process.

   A user is registered on the system, given a username and password and assigned a role. Example: the CEO is registered and assigned a role of CEO. The CEO role has access to view all information on the system. With this role restriction, the CEO will not be able to change financial data; instead, only the role allocated to that task will be able to do so.

   The roles used in this system can be seen in section 3.1

5. Use symfony framework to access database

   During the installation process of Drupal, it creates its own database for specific purposes. The information system developed in this project has a separate database that is external to the drupal database. To access the database, there is need to use symfony framework; create a custom module in drupal; use services and edit settings of the web application.

These were the steps used in accessing the database

a. Add the external database to the web application

   From the file manager on CPanel, locate settings.php file which has been created during the drupal installation process through this file path: sites/default/settings.php

   In Appendix D, we find the code used to add the external database.

b. Custom Module

   Drupal comprises of modules that adds new features or extends functionality of Drupal core. A new module 'access_database' was created to add a new feature of accessing external database. The directory for the module is modules/Custom/access_database. access_database.info.yml, access_database.routing.yml and access_databaseController.php are files created in the process of module creation.

   access_database.info.yml provides information about the custom module created.

   access_database.routing.yml provides the route through which we can access the module. '/hello' is the path to the module. Appendix E shows code used to create custom module.

   access_databaseController.php is saved in a directory 'modules/Custom/access_database/src/Controller/access_databaseController.php'. This file controls the functions the module performs and the output. This code can be found in Appendix C.

c. Use service

   Drupal services are used to perform operations like accessing the database or sending an e-mail. We use the core-provided service via the service container to conduct this action instead of using PHP's native MySQL methods so that our code may simply access the database. Services decouple reusable functionality and they are pluggable and replaceable by registering them with a service container.

access_database.db_service is the service created for the access_database custom module. It is stored in access_database.services.yml file. Appendix F shows this code. A connection to the external_database is first established and the services functions are stored in file 'accessService.php'. the insertDatabase function inserts data into the database while the viewDB function is to retrieve the data. accessService.php is in Appendix B.

4.2. Result

The information system developed was able to successfully insert data into an external database and retrieve data. The system was developed based on the methodology and implementation procedures discussed above.

Below is an output of data from the system. The code retrieved data from Supplier table in the database. This data can be seen in Figure 4.1


```
[{"Supplier_ID":"27","Supplier_name":"Emey
Corporation","Date_of_joining":"2021-02-
04"},{"Supplier_ID":"26","Supplier_name":"LAAC
Corporation","Date_of_joining":"2020-10-01"}]
```


Figure 4.1: Data retrieved from Supplier

Evaluation of an Information System is done by the measure of the level of response to the project specification. It **CAN NOT** be measured in terms of speed or code volume, nor a comparative study of similar project.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The importance of good data modelling cannot be over emphasized in any field. Data management through information system can be used in any aspect of life – business, schools, organizations, agriculture, health etc. The integrated information system developed for cashew nut processing can also be used in other agricultural initiatives.

Integrated Informaton System (IIS) makes data storage, retrieval and modification available within seconds. This saves time compared to manual information storage and retrieval. The system developed is a web application which makes it accessible from anywhere in the world with internet access.

5.2. Challenges

Major challenge encountered during the project was adequate information on drupal 9 and symfony framework. Drupal 9 is a new release of Drupal CMS and has lot of changes regarding data abstraction and access of external database was made. It took a lot of work and research to be able to use symfony and Drupal services in accessing the database.

5.3. Further Work

As a future work, Symfony form can be added to the system for a better graphical user interface of the system. This will further simplify the data input, retrieval and modification process.

APPENDIX A: CREATE DATABASE CODE

```
CREATE TABLE Staff(
   ID VARCHAR(50),
   First_name VARCHAR(50),
   DOB DATE,
   Date_of_joining VARCHAR(50),
   Resignation_Date DATE,
   PRIMARY KEY(ID)
);

CREATE TABLE Surname(
   surname VARCHAR(50),
   PRIMARY KEY(surname)
);

CREATE TABLE Act_of_Surname_Change(
   Act_ID VARCHAR(50),
   dateChanged DATE,
   ID VARCHAR(50) NOT NULL,
   PRIMARY KEY(Act_ID),
   FOREIGN KEY(ID) REFERENCES Staff(ID)
);

CREATE TABLE State(
   State VARCHAR(50),
   PRIMARY KEY(State)
);

CREATE TABLE Salary(
   Id VARCHAR(50),
   Amount INT,
   PRIMARY KEY(Id)
);

CREATE TABLE Post(
   positionID VARCHAR(50),
   job_Title VARCHAR(50),
   PRIMARY KEY(positionID)
);

CREATE TABLE Marital_Status(
   Status_ID VARCHAR(50),
   Status VARCHAR(50),
   PRIMARY KEY(Status_ID)
);

CREATE TABLE Supplier(
   Supplier_ID VARCHAR(50),
   Supplier_name VARCHAR(50),
   Date_of_joining DATE,
   PRIMARY KEY(Supplier_ID)
);

CREATE TABLE Product_Price(
   Amount VARCHAR(50),
   PRIMARY KEY(Amount)
);
```

```
CREATE TABLE Product_Category(
  Category_ID VARCHAR(50),
  Category_name VARCHAR(50),
  PRIMARY KEY(Category_ID)
);

CREATE TABLE Act_of_Change_of_MS(
  AC_ID VARCHAR(50),
  date_of_Change DATE,
  Status_ID VARCHAR(50) NOT NULL,
  ID VARCHAR(50) NOT NULL,
  PRIMARY KEY(AC_ID),
  FOREIGN KEY(Status_ID) REFERENCES Marital_Status(Status_ID),
  FOREIGN KEY(ID) REFERENCES Staff(ID)
);

CREATE TABLE Act_of_Salary_change(
  AC_ID VARCHAR(50),
  date_of_Change DATE,
  Id VARCHAR(50) NOT NULL,
  ID_1 VARCHAR(50) NOT NULL,
  PRIMARY KEY(AC_ID),
  FOREIGN KEY(Id) REFERENCES Salary(Id),
  FOREIGN KEY(ID_1) REFERENCES Staff(ID)
);

CREATE TABLE Act_of_post_change(
  AC_ID VARCHAR(50),
  date_of_change DATE,
  ID VARCHAR(50) NOT NULL,
  PRIMARY KEY(AC_ID),
  FOREIGN KEY(ID) REFERENCES Staff(ID)
);

CREATE TABLE Customer(
  Customer_ID VARCHAR(50),
  C_telephone VARCHAR(50),
  C_name VARCHAR(50),
  PRIMARY KEY(Customer_ID)
);

CREATE TABLE Purchasse(
  Purchase_ID VARCHAR(50),
  Quantity VARCHAR(50),
  Payment_mode VARCHAR(50),
  PRIMARY KEY(Purchase_ID)
);

CREATE TABLE Telephone(
  telephone INT,
  Supplier_ID VARCHAR(50) NOT NULL,
  ID VARCHAR(50) NOT NULL,
  PRIMARY KEY(telephone),
  FOREIGN KEY(Supplier_ID) REFERENCES Supplier(Supplier_ID),
  FOREIGN KEY(ID) REFERENCES Staff(ID)
);

CREATE TABLE LGA(
  lga VARCHAR(50),
  State VARCHAR(50) NOT NULL,
  PRIMARY KEY(lga),
  FOREIGN KEY(State) REFERENCES State(State)
);
```

```
CREATE TABLE Product(
   Product_ID VARCHAR(50),
   Product_Name VARCHAR(50),
   Supplier_ID VARCHAR(50) NOT NULL,
   Category_ID VARCHAR(50) NOT NULL,
   PRIMARY KEY(Product_ID),
   FOREIGN KEY(Supplier_ID) REFERENCES Supplier(Supplier_ID),
   FOREIGN KEY(Category_ID) REFERENCES Product_Category(Category_ID)
);

CREATE TABLE Act_of_price_change(
   AC_ID VARCHAR(50),
   dateChanged DATE,
   Product_ID VARCHAR(50) NOT NULL,
   Amount VARCHAR(50) NOT NULL,
   PRIMARY KEY(AC_ID),
   FOREIGN KEY(Product_ID) REFERENCES Product(Product_ID),
   FOREIGN KEY(Amount) REFERENCES Product_Price(Amount)
);

CREATE TABLE Town(
   town VARCHAR(50),
   lga VARCHAR(50) NOT NULL,
   PRIMARY KEY(town),
   FOREIGN KEY(lga) REFERENCES LGA(lga)
);

CREATE TABLE Address_ID(
   address_ID VARCHAR(50),
   House_number VARCHAR(50),
   Street_name VARCHAR(50),
   town VARCHAR(50) NOT NULL,
   PRIMARY KEY(address_ID),
   FOREIGN KEY(town) REFERENCES Town(town)
);

CREATE TABLE Address_Change(
   ACID VARCHAR(50),
   address_ID VARCHAR(50) NOT NULL,
   ID VARCHAR(50) NOT NULL,
   Supplier_ID VARCHAR(50) NOT NULL,
   PRIMARY KEY(ACID),
   FOREIGN KEY(address_ID) REFERENCES Address_ID(address_ID),
   FOREIGN KEY(ID) REFERENCES Staff(ID),
   FOREIGN KEY(Supplier_ID) REFERENCES Supplier(Supplier_ID)
);

CREATE TABLE Concern(
   surname VARCHAR(50),
   Act_ID VARCHAR(50),
   PRIMARY KEY(surname, Act_ID),
   FOREIGN KEY(surname) REFERENCES Surname(surname),
   FOREIGN KEY(Act_ID) REFERENCES Act_of_Surname_Change(Act_ID)
);

CREATE TABLE Concern_Post(
   positionID VARCHAR(50),
   AC_ID VARCHAR(50),
   PRIMARY KEY(positionID, AC_ID),
   FOREIGN KEY(positionID) REFERENCES Post(positionID),
   FOREIGN KEY(AC_ID) REFERENCES Act_of_post_change(AC_ID)
);
```

```
CREATE TABLE has_Purchase(
  Customer_ID VARCHAR(50),
  Purchase_ID VARCHAR(50),
  PRIMARY KEY(Customer_ID, Purchase_ID),
  FOREIGN KEY(Customer_ID) REFERENCES Customer(Customer_ID),
  FOREIGN KEY(Purchase_ID) REFERENCES Purchasse(Purchase_ID)
);

CREATE TABLE concern_price(
  Product_ID VARCHAR(50),
  Purchase_ID VARCHAR(50),
  Price VARCHAR(50),
  PRIMARY KEY(Product_ID, Purchase_ID),
  FOREIGN KEY(Product_ID) REFERENCES Product(Product_ID),
  FOREIGN KEY(Purchase_ID) REFERENCES Purchasse(Purchase_ID)
);
```

APPENDIX B: DATABASE FUNCTION CODE

accessService.php

```
<?php

namespace Drupal\access_database\Service;

use Drupal\Core\Database\Connection;
use Drupal\Core\Database\Database;

class accessService
{
    /**
     * @var Connection
     */
    protected $database;

    public function __construct(Connection $connection)
    {
        $this->database = $connection;
        Database::setActiveConnection('external_database');
    }

    public function insertDatabase()
    {
        $results = Database::getConnection()->insert('Supplier')
        ->fields(['Supplier_name', 'Date_of_joining'])
        ->values([
            'Supplier_name' => 'Emey Corporation',
            'Date_of_joining' => '2021-02-04'
        ])
        ->execute();
        $result1 = Database::getConnection()->insert('Address_ID')
        ->fields(['House_number', 'Street_name','town'])
        ->values([
```

```
            'House_number' => '23',
            'Street_name' => 'OKY way',
            'town' => 'Gwagwa'
        ])
        ->execute();

        $result2 = Database::getConnection()->insert('Address_Change')
        ->fields(['address_ID', 'ID','Supplier_ID'])
        ->values([
            'address_ID' => @$result1,
            'ID' => '0',
            'Supplier_ID' => @$results
        ])
        ->execute();

        Database::setActiveConnection();
        return $result2;
    }

    public function viewDB()   //function to view data
    {
        $results = Database::getConnection()->query('SELECT * FROM Supplier')
->fetchAll();
        Database::setActiveConnection();
        return $results;
    }

}
```

APPENDIX C: MODULE FUNCTION CODE

access_databaseController.php

```
<?php

namespace Drupal\access_database\Controller;
use Drupal\access_database\Service\accessService;
use Symfony\Component\HttpFoundation\JsonResponse;
use Drupal\Core\Controller\ControllerBase;
use Symfony\Component\DependencyInjection\ContainerInterface;

class access_databaseController extends ControllerBase {

    /**
     * @var accessService
     */
    private $dbGenerator;

    public function __construct(accessService $dbGenerator)
    {
        $this->dbGenerator = $dbGenerator;
    }
    public static function create(ContainerInterface $container)
    {
        $dbGenerator = $container->get('access_database.db_service');
        return new static($dbGenerator);
    }
    public function first()
    {
        $results = $this->dbGenerator->viewDB();
        return new JsonResponse($results);
    }
}
```

APPENDIX D: ADD EXTERNAL DATABASE

```
$databases['external_database']['default'] = array (
  'database' => 'database name',
  'username' => 'username',
  'password' => 'password',
  'prefix' => '',
  'host' => 'localhost',
  'port' => '3306',
  'namespace' => 'Drupal\\Core\\Database\\Driver\\mysql',
  'driver' => 'mysql',
);
```

APPENDIX E: CREATE CUSTOM MODULE

access_database.info.yml

```
name: access_database
type: module
description: For updating databases
core_version_requirement: ^8.8 || ^9
```

access_database.routing.yml

```
access_database.hello:
  path: '/hello'
  defaults:
    _controller: '\Drupal\access_database\Controller\access_databaseControlle
r::first'
    _title: 'My first page'
  requirements:
    _permission: 'access content'
```

APPENDIX F: SERVICE CODE

access_database.services.yml

```
services:
  access_database.db_schema:
    class: Drupal\Core\Database\Connection
    factory: 'Drupal\Core\Database\Database::getConnection'
    arguments: [external_database]
  access_database.db_service:
    class: Drupal\access_database\Service\accessService
    arguments: ['@access_database.db_schema']
```

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