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University of Nueva Caceres
College of Computer Studies
J.Hernandez Ave. Naga City

DESIGNING A LOGICAL DATA MODEL FOR A DY POS AND INVENTORY MANAGEMENT SYSTEM

Presented By: Jan Ryan Relunia

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Presented To:

JUNE ARREB DANILA

Marvin Monteagudo

Irvin Villanueva

ABSTRACT

The retail business vision is to maximize profit from customer satisfaction and loyalty towards the store by providing more personalized service for the customer. However, the retail business also easy to lose its possible customer if they do not have sufficient stocks in the store. Thus, in this paper, the developer had identified problems related to inventory that exists in Tokyo Gadgets Store. The major problem of the store is they do not have a proper inventory control system in guiding and managing their sale and inventory level of the store.

By proposing a Sale & Inventory Management System to the store as the replacement of old manual ways, the project aims in providing the system with enhanced and more flexible functions to the store. The objective of the system is to provide functions in managing goods in the store more efficiently. To achieve the objectives derived, the scope of the project will focus on the aspects such as database, report generating, quality control (QA), and point of sale of the store. Besides, the development of the system will be based on an offline system or window based.

In developing the system, a phase development prototype is chosen. This methodology Wii performs the development stage according to modules underlines in the scope of the project. Thus, version by version of the system will be developed before the whole complete system is ready to use. The expected result of the system is that the user interface to be developed will be user-friendly so that it can be handled easily by people with no IT background. Besides, the system is also expected to serve its functions and helps Tokyo Gadget Store in reducing time and paperwork in managing their inventory.

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INTRODUCTION

PROJECT BACKGROUND

The retail industry is one of the industries that is growing in fast pace where the number of retail business keep on increasing from time to time to meet the demand from consumers of specified areas. There are different types of retail shops available for the consumer to choose ranging from hypermarket to mini market according to their convenience. Most of the shops can be found in residential areas, streets, or a shopping mall. Retail store sells a wide range of goods and services from wholesaler or supplier to the end-user. Thus, the nature of the retail business required good management of inventory level to meet the demand of the customers.

The traditional way retailer keeps their sales and inventory details is in spreadsheets which are not effective anymore when the size of the shop gets bigger. This is because more items will be made available in a larger quantity, thus tracking the sales made with inventory level in the shop would be complicated and time-consuming for the retailer. Besides, the situation gets worst when the retailer does not have a proper method to determine items purchased by their customers.

Thus, this project will provide a solution for retailers that are still using traditional ways in keeping their inventory data like 'Tokyo Gadgets Store, by creating POS and Inventory system Management System is a computer-based system that provides the shop structure for maintaining and controlling goods to be stocked. The approach of Sales and Inventory Management System is commonly used to avoid product overstock or outrages by integrating daily 'Point of Sales' with store's inventory level

Problem Identification

POS and Inventory is one of the important departments that must be well managed to ensure daily business activities run smoothly. However, Tokyo Gadgets Store still does have an Inventory management system or POS as they are not equipped with a computerized system in running their business. As a result, the security level of all data, documents, and anything that related to daily transaction and inventory is very low. A lot of documents have been kept for each good and for each supplier which consumes a lot of time and not effective for future references. Besides, due to poor POS and inventory management, Tokyo Gadgets Store also faces problems in identifying the quantity sold for each item per day and the available inventory level of the items lose product and money. Existing inventory management also does not provide any means of detecting aging Products like Power Bank, connector Rex Pods, Tablet, Laptop, etc. Failure to identify the aging of certain Items causes the store to incur losses profit because when the item like to Tokyo Gadget Store is just stock for a long period time and the item lose their value due of being stock for a long period time.

As the current system used just acts as calculated to calculate the total amount of each customer purchase and does not any database link with it, the system does not have the capability of generating a report on point of sales at the end of the day. Thus, there is no proper guideline in making reports in the store's logbook which result in different kind of reports being prepared each time. The simple report which is about the total sales of the day is determined based on the amount of money in the cashier deck does not provide any input for the owner to make the right decision regarding the business operation. In case there is a shortage of cash at the cashier's desk or any stolen cases, the owner cannot detect it as the current system does not have a database to store the total sales of the day.

Another identified problem is that the customers who made their purchases at the store usually do not receive a proper receipt as references. Instead, only the receipt contains prices being generated by the system. Thus, customers face a problem when they wanted to change the items bought due to damage, expired, or wrongly purchase as the receipt does not indicate the name of items which makes it hard for the customers to prove that they bought them within 3 days in Tokyo Gadget Store.

POS and Inventory Management Database Design phase

The database design process is divided into different sets of design tasks according to the design process being followed. This thesis' work shall focus on the logical database design. The physical database design phase shall only be introduced.

Logical Database Design

The focus on logical database design is to find the user requirements, study the existing system finding the problems users are having with the current system and study the company business environment. The outcome is the development of a system-independent description of a database that shall fulfil all the requirements.

Physical Database Design

The physical database design is the actual implementation of the database into the system. The physical database design depends on the Relational Database Management System (DBMS) selected by the user or designer. It depends on the hardware and software environment. The graphical representation of the database design approach that is followed for this purpose is shown below:-

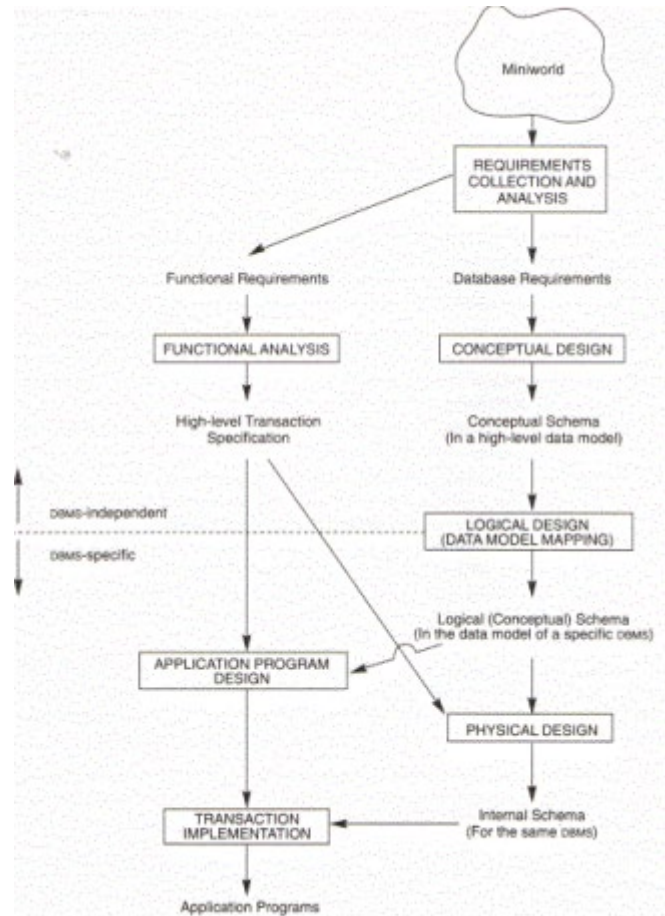


Figure 1. A simplified diagram to illustrate the main phases of database designs

Requirement collection and Analysis

Knowing the requirements and needs of clients is vital to the success of a project. Hence we will be following some approaches to finding facts. The following are some of the most widely used fact-finding techniques used to find facts about the needs and requirements of the company:-

- Examining documentation
- Interviewing
- Observing the enterprise in operation
- Research
- Questionnaires.

The purpose of using this fact-finding technique is to find out

- the aims and objectives of POS & IMS plus from users point of view
- the different users' view
- the system requirements and performances as well as security requirements
- The functional features company wishes to have in the system.

Requirements collections

In this step, the methods used to collect the enterprise data requirements have been described.

Examining Documentation

All the documents from the past operations of company were examined and studied. The following were the documents that were studied during the process:-

- a. Inventory Record
- b. Sales Record
- c. Product List
- d. Invoice's process
- e. Staff Record

Interviewing and Questionnaires

The CEO and all staff members currently employed in the company were interviewed. The purpose of the interviews was to gather further information on the problems the staff are facing and their possible solution from the new system that is to be developed. The interviews were conducted as a structured interview. All the interviewees were asked both open-ended as well as closed-ended questions. The following were the questions asked during the interview.

Interview and Observations

i. Background of Interview

I'm Thomson Dy, 23 years old, I started doing business when I was 18 back when I was in Manila. I put up my min restaurant in Quezon city since my mom has her restaurant in Bicol and I learned a bit from her. That's when I started to have an interest in doing business and up until this day I have discovered my skills in business, especially in retail. Tokyo Gadget started last October 2020 when there was a hype of digital-based technology like computer and the like it.

ii. Purpose of Interview

- To uncover further problems regarding POS and Inventory management using manual ways
- To understand the current methods and approach being used in doing daily sales transaction by the staffs
- To identify the main features or functionalities to be integrated into the project prototype

iii. Interview Question

1. What is the current method of recording Inventory Products and Sales on the Tokyo Gadget Store?
2. What's the problem faced by the store in managing inventory and sales?
3. Did the customer complain about the product they out of stock?
4. How do you monitor the performance of the store?
5. What if the customer wishes to exchange the item purchased?
6. Why never use any system in doing business?
7. Will you use a system that will help you in managing the inventory and your sale?
8. What are you requirement in the system to be development?

iv. Summary of Interview Results

1. The current method that Tokyo Gadget uses now is more on paper.
2. The problem is more about managing the Inventory of Products that (In and out) the daily sales and same time we encounter a problem in sale management and inventory management that done by our employee like their lose item base on inventory but we can never find it where have been even we look at the receipt and on lab book we can't. Then only we can think is done by my employee I can only think on scenarios on that case. We can't judge our employee if we don't have any solid evidence to prove that our employee is guilty.
3. We always encounter a customer looking for a specific product or product that is on lap book but doesn't have stock in the store. When a customer

needed a product that we don't have on our lab book we can only if he/she what to order that product but he/she need to pay 50% price of the total price of the item the customer what to. When encounter a customer looking for a product but we out of stock what we do is write it on a blackboard the product needed to re-stock.

4. By looking at sales report that sends on messenger. We give a task to our employee that always sends the daily sale when they close the store every night in that way we can see daily what is the sale on store and we as our on chat or call on the situation of the store on that day.
5. Our store has a rule the 2-week replacement for all Item with that to weeks if customer what replace the Item we ask for the reason why they what to replace the item, if the item is manufacture defective product we offer to the customer a replacement on the same product but if the customer doesn't have them to replace the item a refund the money we allow that we just ask for customer permission for basic information like name, reason, and signature and we ask for the receipt of the product that they buy if they don't have a receipt we ask to just back get the receipt if they say that the loss we do not allow that and we deeply explain our rule.
6. I wanted to use and modernize the current system that we use but do not have on my plan right now.
7. If the Software is very helpful in managing the Sale and Inventory. I use it for my business is big help managing the business you can do many things and big help because I do many things just to monitor may store in Bicol.
8. What I want is online and when you login in the system and the data is online for me can access the system even if I home or I out of town I can easy to access just need internet and I what that attendance of my employee for me can monitor my employee performance.

9. The system has an inventory table and admin and employee access for the security of data, system is simple and easy to operate even the user the goanna uses the system can easily use it. The database I want the data can see daily sales, weekly can generate report to the sale inventory report monthly. The data can print in a table.

Database Requirements

Initial Database Size

Currently the Tokyo Gadget Store employs in total five staffs, two sales staffs, staffs a C.E.O and two delivery staff and an accountant. The company is working as a distributor for three different store. The number of products each store are different from each other. All the products the company distributes shall be stored in the database of the POS & IMS plus system.

Database Growth

In future the company expects to acquire more store contract from other store and suppliers. Increases in the types of products from the store will result in increased data in the database. The company wishes to grow more from other stores in the future.

Security

The system will be password-protected. Each user will be assigned system access privileges appropriate to the particular user view. Staff members shall see only the data necessary to perform their job. The system will be disconnected from World Wide Web to prevent all possible hacking and cracking from the Internet. The system should only be accessed from local workstations.

Requirements

Functional Requirements

After the staff interviews and the study carried of the documents, the functional requirements of the Tokyo Gadget Store were identified. The functional requirements of the system vary for each user group. Hence the functional requirements of the system are categorized for each user. The following are the functional requirements of the system.

Administration Functional Requirements

The CEO acts as the system administrator.

- System login function, with password change functionality after login
- Create new user of the system with staff details, limit their privileges according to their job description
- Add new item and category into system product list
- Edit and update product prices
- Remove item and category from inventory with precautions message
- Delete and update system users

POS Manager Functional Requirements

- System login function through the user interface and change password after first login.
- View inventory status
- Products search function by product code or by product name or by product category
- Check bills generated for the day
- Check money transaction for the day
- Check the bills cancelled
- Check returned products
- Generate sales-trend graph.

Inventory Manager Function Requirements

- System login function through user interface and change password after first login
- Add product details and prices into the system
- Check the inventory status, minimum and maximum stock point and order point
- Update the inventory according to the sales done in previous day
- Create inventory reports of items category-wise, price-wise
- Generate inventory-trend graphs.

Salesmen Functional requirements

- System login function and change password function

- View the inventory status
- Product search function by product name or product code or product category
- Create purchase order entering purchase details
- Cancel the bills in case of error in entering the details
- Enter the product details for the returned order.

Users' transaction requirements

The operations operated over the database objects are transaction. The minimum required user transactions are described in this section which should be implemented during physical database design process. The transaction requirements for the company were discovered during the company's document analysis and fact collecting techniques used to collect user's views and ideas about the system.

Data entry

Enter the detail of suppliers
 Enter the details of products
 Enter product category details
 Enter product brand details
 Enter product store details
 Enter new and existing staff's details
 Enter role details of each staff
 Enter customer details.
 Enter order, order details.
 Enter dispatched order details.
 Enter payments details.

Data update/deletion

Update/delete staff details.
 Update/delete product details.
 Update/delete product category details.
 Update/delete product brand details.
 Update/delete product store details.

Update/delete order, order details.
 Update/delete customer details.
 Update/delete supplier details.
 Update/delete payment details.

Data query

- List the details of staffs.
- List details of each staff roles.
- List details of suppliers.
- List details of each product.
- List products in stock.
- List products reaching minimum stock level.
- List products hitting re-order level.
- List products by category
- List available category details.
- List products by brand
- List available brand details.
- List products by store
- List available store details.
- List customer details.
- List all incoming order details
- List all dispatched order
- List payment details for recent orders
- List orders with credit payments and customer details
- List total number of order.
- List orders with full payments (balance 0).

In this chapter, the required users' transactions are described. The reports that need to be generated using the systems are described in this chapter. The design of the reports shall be designed by the physical designer meeting the needs of the company's current report formats.

Functional Analysis

In this step of design process, the brief analysis of all the function that user wishes to have in the system is described.

Input

The data that shall be fed into the system will be inserted by the user of the system. The data each user feeds to the system is different. The following are the types of data that will be fed to the system:

- Username, password and new changed password
- New user details
- Product details and category
- Product details and brand
- Product details and store
- Incoming product details
- Order details
- Cancelled bills
- Return products details

Process

After the data is fed to the system, the system will process data to generate output. The processes that should be processed by the system are as follows:

- Authentication of existing username and password
- Save any changes to database (add, delete, update products/categories/brand/store)
- Carry the search within database
- Generate bill for the sales item
- Cancel the bills generated in case of error
- Produce invoice for the purchase order
- Produce bills or reports for return purchase
- Validate the inventory stocks
- Generate reports on minimum stock point maximum stock point and order point

Output

The system processes the data that is fed into the system. The system shall produce different kinds of reports as the outputs. The following are the outputs the system shall produce:

- Product lists
- Maximum stock point, minimum stock point, order point

- Detailed reports on purchase and sales
- Reports on dispatched orders
- Reports on due payment from clients over certain period of time
- Inventory trends and graphs
- User information and clients information
- Product details on execution of search query

Conceptual Database Design

In this step of project, the conceptual database methodology IS used for database design during the database development lifecycle for a relational database is described.

Definition

Conceptual database design: The process of constructing a model of data used in an enterprise, independent of all physical consideration. (Connolly, 2005, p.439)

In database design process, the first phase of database design after the collection and analysis of user requirements is the conceptual database design. The purpose of this design process is the creation of a conceptual data model independent of Database Management System software, application programs, programming language, hardware platforms or any other physical systems. During the process, user specifications and requirements are closely followed.

The conceptual data model is tested and validated with the users' requirements and specification. A well designed conceptual data model is the key for success of next phase of design process: Logical Database design and whole database system in general.

Conceptual Database Design Methodology

The idea of using a design methodology is to give structure to the procedures, techniques, tools and documentation to support and facilitate the process of designing. The following are the steps in methodology that are followed during the conceptual database design process for the company.

Using the conceptual database design methodology as described by Connolly in his book: A Practical Approach to Design, Implementation and Management, the conceptual data model shall be designed.

Identifying entity types

The process of identifying entity types involves reorganization of user interested objects. User requirements specification is vital to the success of identification of

entities. The company has two types of staff, namely, warehouse staff and sales staff who will use the system the most. Hence the entity is identified classifying the entity type.

Nonfunctional Requirements

I. Software Requirements

- a) MS Windows 2016 higher
- b) MS Access
- c) MS C#

II. Hardware Requirements

- a) Pentium-II 500 MHz
- b) 300 MB hard disk space
- c) 256 MB RAM
- d) 10Base-T Network Interface Card
- e) Laser Printer

III. Security Requirements

- a) User name and Password identification for all users
- b) MS Windows Primary Domain Controller

IV. Reliability/Survivability Requirements

- a) 8:00am – 9:00pm availability on those days
- b) Data restoration within 24 hours of data loss
- c) Daily/Nightly back-ups of database

V. Interface Requirements

- a) Simple interface
- b) No large user manual required
- c) Short training session

VI. Lifecycle Requirements

- a) System upgradeable
- b) Development time < 6 months

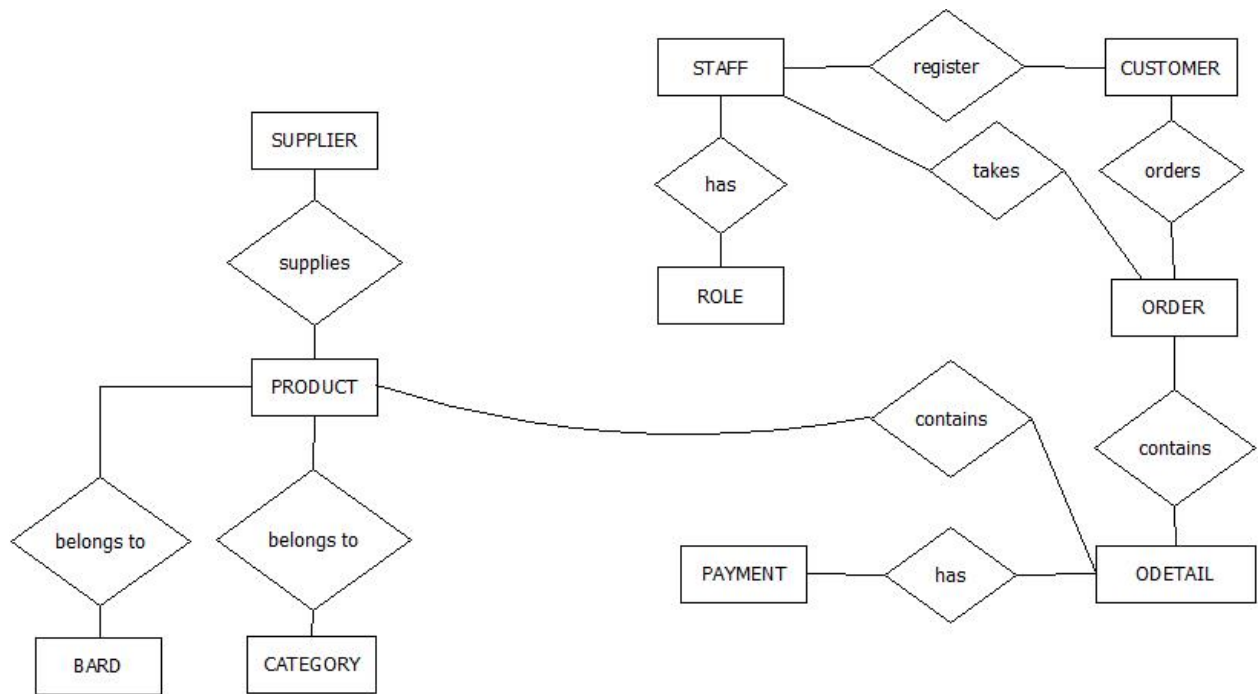


Figure 2. Documentation of Attributes and Entities

Staff

Staff ID, FirstName, LastName, DateOfBirth, Address, role ID, phone No, username, password

Role

Role ID, roleName, Description

Customer

Customer ID, FirstName, LastName, Address, phone, Email, BusinessRegNo,

Order

OrderID, BillNo, Staff ID, CustomerID, OrderDate, DispatchedDate, PaymentID, ErrorMessage, Deleted, Paid,

OrderDetails

OrderID, BillNo, ProductId, Price, OrdQuantity, DelQuantity, Discount, Total, Size, OrdDate, DispatchDate, OrderDetailID, BillDate

Payment

paymentID, PaymentType, CreditAmount, DebitAmount, Balance, BalanceDate,

Product

ProductID, ProductName, ProductDescription, SupplierID, CategoryID, QuantityPerUnit, UnitPrice, UnitWeight, Size, Discount, UnitsInStock, UnitsonOrder, ReorderLevel, ProductAvailable, CurrentOrder, Note

Category

CategoryID, CategoryName

Brand

BrandID, BrandName

Store

StoreID, StoreName

Supplier

SupplierID, CompanyName, ContactFname, ContactLname, ContactTitle, Address, Phone, Fax, Email, PaymentMethods, DiscountType

Relational Data Model

(Entities, Attributes & Constraints)

Table Cart

Cart_id(PK,SA)
Transno(NN)
Product_code(NN)
BarCode(NN)
Price(NN)
Quantity(NN)
Discount(NN)
Total(NN)
Sdate(NN)
Status(NN)

Table Product

Product_Code(PK,SA)
BarCode(NN)
Brand_id(FK)
Category_id(FK)
Price(NN)
Quantity(NN)

Table Brand

Brand_id(PK,SA)
Brand(NN)

Table Category

Category_id(PK,SA)
Category(NN)

Table Stock

Stock_id(PK,SA)
Refno(NN)
Product_Code(FK)
Quantity(NN)
Stock_Date(NN)
Stock_Status(NN)

Table: **Staff**

Field Name	Data Type	Field Length	Constrain	Description
Staff_id	Integer	10	Primary Key	Staff id on data base
Name	Varchar	50	NN	Full name of staff
Firstname	Varchar	50	NN	Firstname of staff
Lastname	Varchar	50	NN	Lastname of staff
DateOfBirt	Date	10	NN	Bday of staff
Address	Varchar	50	NN	Ifo address
roleID	Varchar	50	Foreign Key, NN	Staff ID
username	Varchar	50	NN	Staff user name
password	Varchar	50	NN	Staff password

Table: **Role**

Field Name	Data Type	Field Length	Constrain	Description
Role_id	Integer	10	Primary Key, SA	role_id
Role_name	Varchar	50	NN	Name of role or position

Table: **Customer**

Field Name	Data Type	Field Length	Constrain	Description
Customer_id	Integer	10	Primary Key	customer id on data base
Name	Varchar	50	NN	Full name of customer
Firstname	Varchar	50	NN	Firstname of customer
Lastname	Varchar	50	NN	Lastname of customer
DateOfBirt	Date	10	NN	Bday of staff
Address	Varchar	50	NN	Ifo address

Staff_id	Varchar	50	Foreign Key, NN	Staff who register the customer
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Table: **Order**

Field Name	Data Type	Field Length	Constrain	Description
Order_id	Integer	10	Primary Key, SA	Order id
Staff_id	Integer	10	Foreign Key, NN	Staff id
Product_id	Integer	10	Foreign Key, NN	Product id
Order_Date	Date	10	NN	Order date of product

Table: **Payment**

Field Name	Data Type	Field Length	Constrain	Description
Bill_NO	Integer	10	Primary Key, SA	payment id
Payment_amount	Decimal	18,2	NN	Amount of product buy
Payment_discount	Decimal	18,2	NN	Discount to product
Payment_date	Date	10	NN	Date of payment
Balance	Decimal	18,2	NN	

Table: **Product**

Field Name	Data Type	Field Length	Constrain	Description
Product_Code	Varchar	50	Primary Key	Product_id
BarCode	Varchar	50	NN	Barcode of product for scanning
Brand_id	Integer	10	Foreign Key, NN	Brand id
Category_id	Integer	10	Foreign Key, NN	Category id
Price	Decimal	18,2	NN	Price of the Product
Quantity	Integer	10	NN	Quantity of Product

Table: **Stock**

Field Name	Data Type	Field Length	Constrain	Description
Stock_id	Integer	10	Primary Key, SA	Product_id
Refno	Varchar	50	NN	Reference number of stock
Product_Code	Varchar	50	Foreign Key, NN	Product id
Quantity	Integer	10	NN	Quantity of Stock
Stock_Date	Date	10	NN	Date of Stock come
Stock_Status	Varchar	50	NN	Status of Stock(Done) or (Pending)

Table: **Stock**

Field Name	Data Type	Field Length	Constrain	Description
Cart_id	Integer	10	Primary Key, SA	Product_id
Transno	Varchar	50	NN	Reference number of cart
Product_code	Varchar	50	Foreign Key, NN	Product id
BarCode	Integer	10	NN	Quantity of Stock
Price	Date	10	NN	Date of Stock come
Quantity				
Discount				
Total				
Sdate	Date	10	NN	Date of Cart panch
Status	Varchar	50	NN	Status of Stock(Done) or (Pending)

Table: **Store**

Field Name	Data Type	Field Length	Constrain	Description
Store_id	Integer	10	Primary Key, SA	Store_id
Store	Varchar	50	NN	Name of store

Table: **Brand**

Field Name	Data Type	Field Length	Constrain	Description
Brand_id	Integer	10	Primary Key, SA	Product_id
Brand	Varchar	50	NN	Brand name

Table: **Category**

Field Name	Data Type	Field Length	Constrain	Description
Category_id	Integer	10	Primary Key, SA	Product_id
Category	Varchar	50	NN	Category name

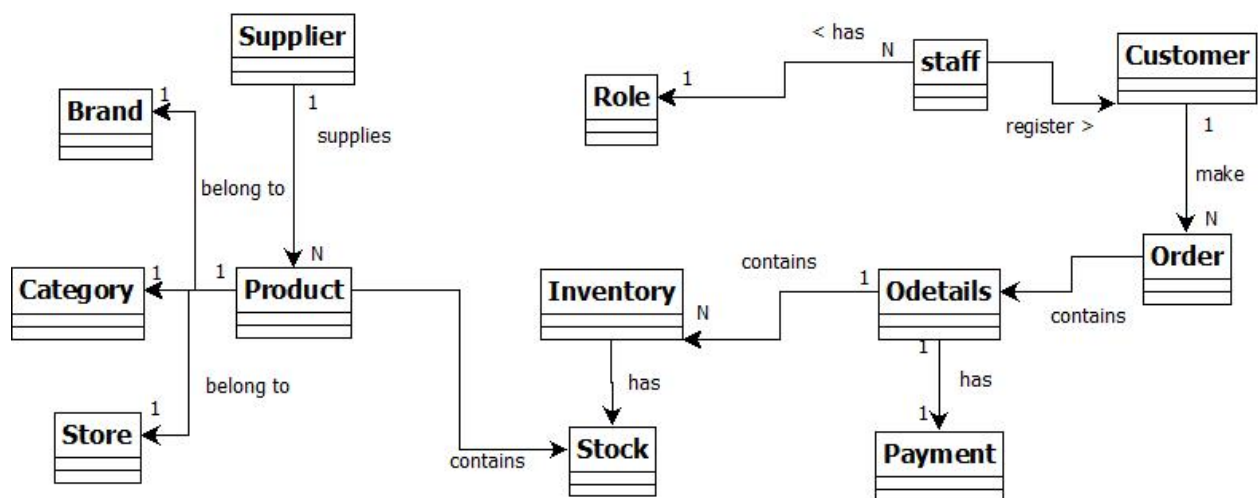


Figure 3. UML diagram with entities and primary keys

Redundancy check for the conceptual model

The system will be inefficient if there are redundant data. The process of redundancy check helps in eliminating any duplicate data if there exists any. The conceptual data model is subjected to the redundancy check. The process carried involves re-examining all the relationships between the entities. The following were the processes carried for redundancy check:-

- a. Re-examining one-to-one relationships
- b. Removing redundant relationships
- c. Considering time dimensions

Conceptual model validation with users' transaction

At this stage, the conceptual data model that represents the enterprise's data requirements is achieved. The purpose of validation is to ensure the data model supports the required transactions of the enterprise.

An attempt to carry out enterprise transactions manually using the data model is performed. The aim is to observe if the transaction succeeds or fails. If the transaction is successful, there is no problem with the data model, otherwise the conceptual model needs to be reviewed and redesigned to meet the enterprise transaction requirements. The following are the approaches carried out to ensure that the conceptual data model meets the transaction requirements:-

- a. Describing transactions
- b. Using transaction pathways

The UML diagram 3 is used to describe the conceptual model validation process with users' transaction.

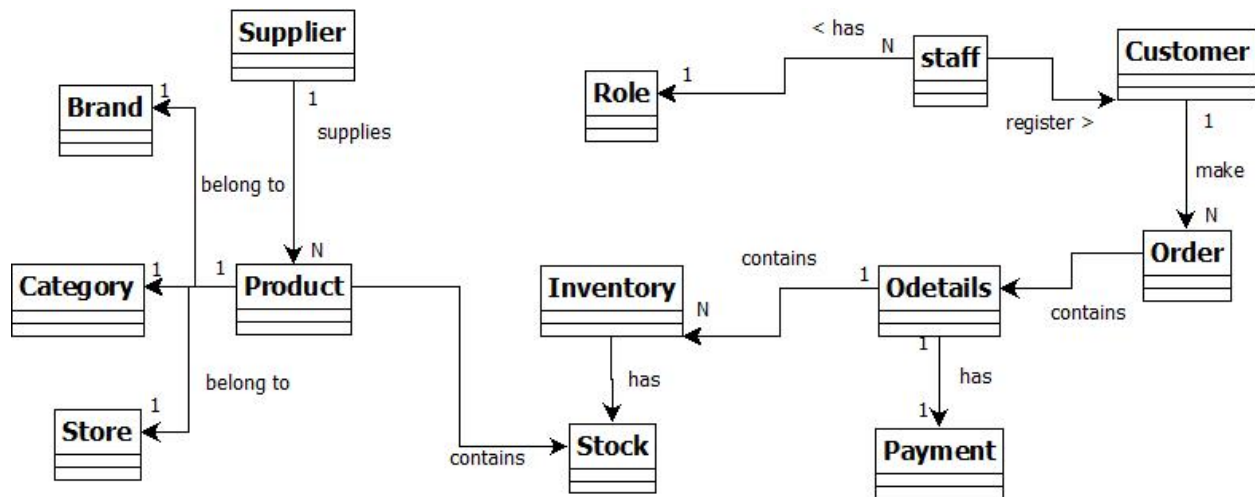


Figure 4. Using pathways to validate conceptual model meets user transaction requirements.

The UML diagram in Figure 8 was used to validate the transaction process. The description of each transaction process is as follows:

- a. Enter/update/delete staff detail and roles.
- b. Enter/update/delete customer details.
- c. List staff/customer details and who register which customer.
- d. List which customer ordered what products, current orders.
- e. Enter/update/delete order.
- f. List products in order by order number of each customer.
- g. Enter/update/delete order details
- h. List credit, debit, balance amounts for each order/bill.
- i. Enter/update debit/credit amount for each order/bill.
- j. List products in each order.
- k. Update/delete products from order (if out of stock).
- l. List/update/delete/ products from category or category.

- m. List/update/delete/ products from brand or brand.
- n. List/update/delete/ products from store or store.
- o. List/update/delete supplier details.

Reviewing the conceptual data model with users

The conceptual data model has been verified with enterprise data requirements and transaction requirements. The data model is reviewed along with the user and user is happy with the positive signs of development process of a well designed database, ready to implement. The next step of the design process is to produce a logical database design from this data model.

Logical Database Design

In this phase of project, the conceptual data model produced in last step is translated into logical data model. The process of translation was conducted following certain process which is described in this chapter

Definition

Logical database design: The process of constructing a model of the data used in an enterprise based on a specific data model, but independent of a particular DBMS and other physical considerations. (Connolly, 2005, p.439)

The objective of logical database design is to convert the conceptual data model into a logical data model. The logical data model is then validated to check structural correctness and support for the required enterprise transactions. A single logical data model that is correct, unambiguous and comprehensive representation of enterprise data requirements is achieved on the completion of logical database design methodology.

Logical database design methodology

The purpose of using a design methodology is to give structure to the procedures, techniques, tools and documentation to support and facilitate the process of designing. The following are the steps in methodology that are followed during the logical database design process for the company.

Deriving relations for the logical data model

The relationship between entities and attributes are derived during this step. The compositions of each relation are described using Database Definition Language (DBDL). The name of each relation is specified using DBDL followed by list of attributes enclosed in brackets. The primary key (pk), alternate key (ak), secondary key (sk) and foreign keys (fk) of the relations are identified.

The relationship between the entities is represented using the primary key/ foreign key mechanism. The 'parent' and 'child' entity are identified to place the foreign key attribute(s). The parent entity posts its primary key as foreign key into the relation that represents child entity. All the primary keys in the ER diagram are represented by being underlined. The relations and attributes of all entity are shown in the diagram 4 below:

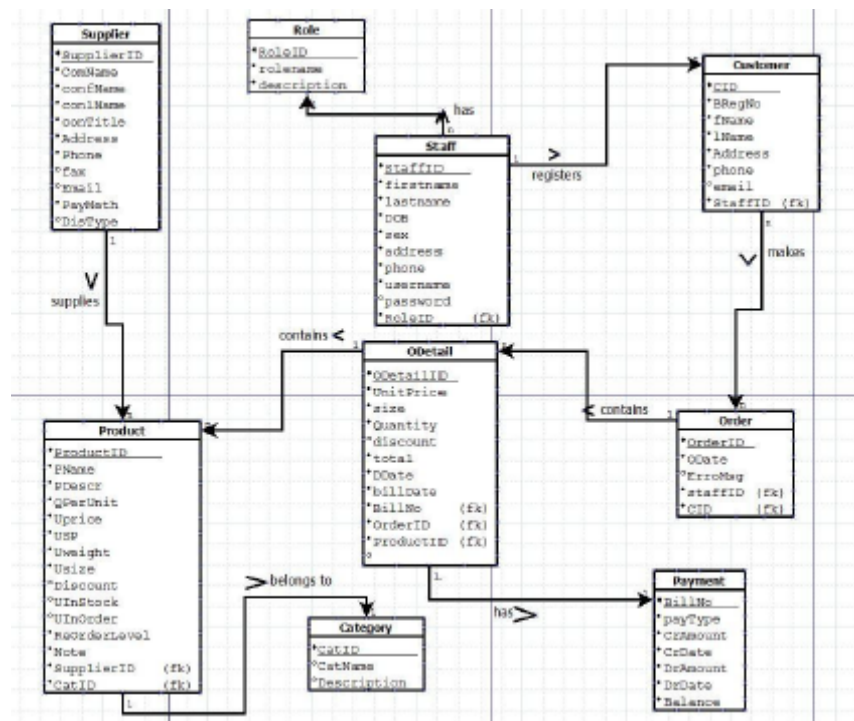


Figure 9. UML diagram representing pk fk mechanism for relationships

Validating relations using normalization

The objective of using the normalization technique is to minimize the number of attributes in entities supporting data requirements of enterprise. This process helps in reducing of data redundancy and solving update anomalies. Some of the redundancies are, nevertheless, essential to form joints in relationship between entities.

The process of normalization of DATA follows different normalization steps, namely First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Fourth Normal Form (4NF), and Fifth Normal Form (5NF). However, for our purpose we are following only up to 3NF as recommended in general. The relations that we are deriving from the conceptual data model, however, might already be in 3NF form. The conceptual model is yet validated using the normalization technique. The relations that are not in 3NF are identified and corrected.

Validating relations against user transactions

The purpose of this step is to ensure that the logical data model supports the required transactions. Although the transaction requirements were validated already during the conceptual data model design process, the logical data model is also validated against the users' transactions requirements.

The primary key/foreign key links from the ER diagram, relations, and data dictionary are used for validation. The process was performed manually as before. All the required transactions were performed successfully validating the logical data model to be correct.

Checking integrity constraints

The constraints in a database are defined to protect the database from being incomplete, inaccurate, or inconsistent are known as integrity constraints. Integrity constraints are mostly controlled by DBMS. The project work is concerned only with high-level design, defining required integrity constraints irrespective of how this might be achieved. It is said (Connolly, 2004) that a logical data model that defines and includes all required integrity constraints is a 'true' representation of enterprise data requirements. In this process, the following types of integrity constraints are considered:-

- Required data

- The attributes that must not be null shall be assigned a value. Some default values are defined to the attributes that requires.
 - o Attribute domain constraints
- The domain pool is the group of attribute values from which the value may be acquired. For gender/sex attribute, the domain pool has only two values 'M' or 'F'
 - o Multiplicity
 - o Entity integrity
- The primary key that uniquely represents entity shall not be null or duplicated.
 - o Referential integrity
- Attributes which are involved in relationship shall not be null, in case of deletion of attributes value in parent entity, default values are defined.
 - o General constraints

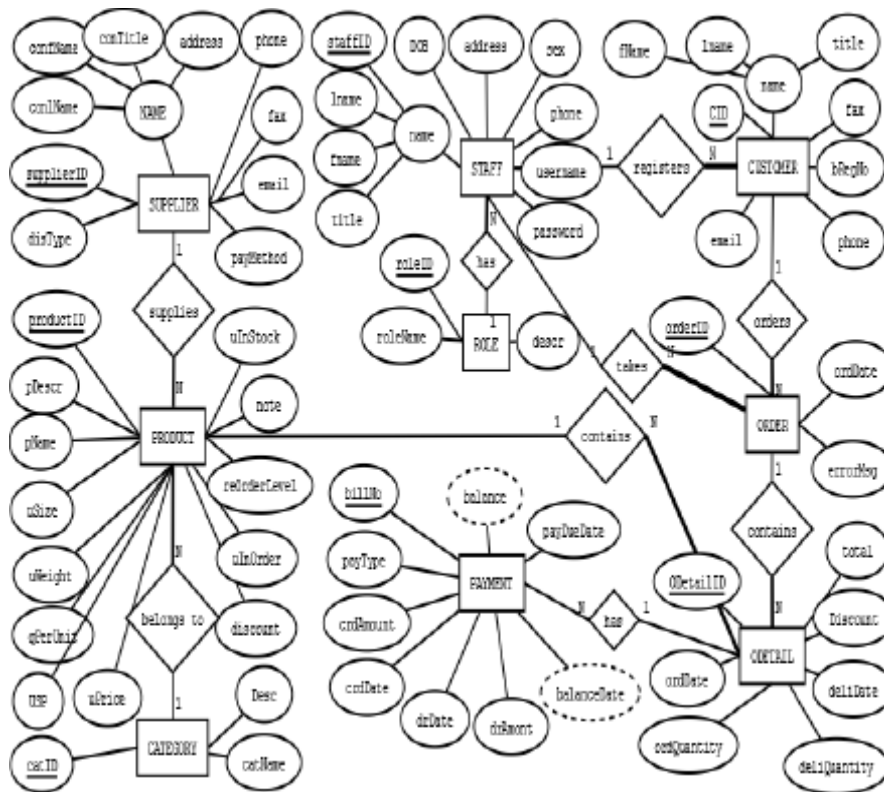


Figure 11. Modified using Chen's Entity-Relation (ER) method for global data model

Designing Security Mechanism

The database stores enterprise resources and data that should be properly secured using proper controls. The objective of this step is to design security mechanism that meets the security requirements documented during the requirements collection and analysis stage of database system development lifecycle. The DBMSs provides different kind of security controls, so it also depends on the selection of RDBMS, however in this step we design general security mechanism that should be followed during the physical implementation of database design.

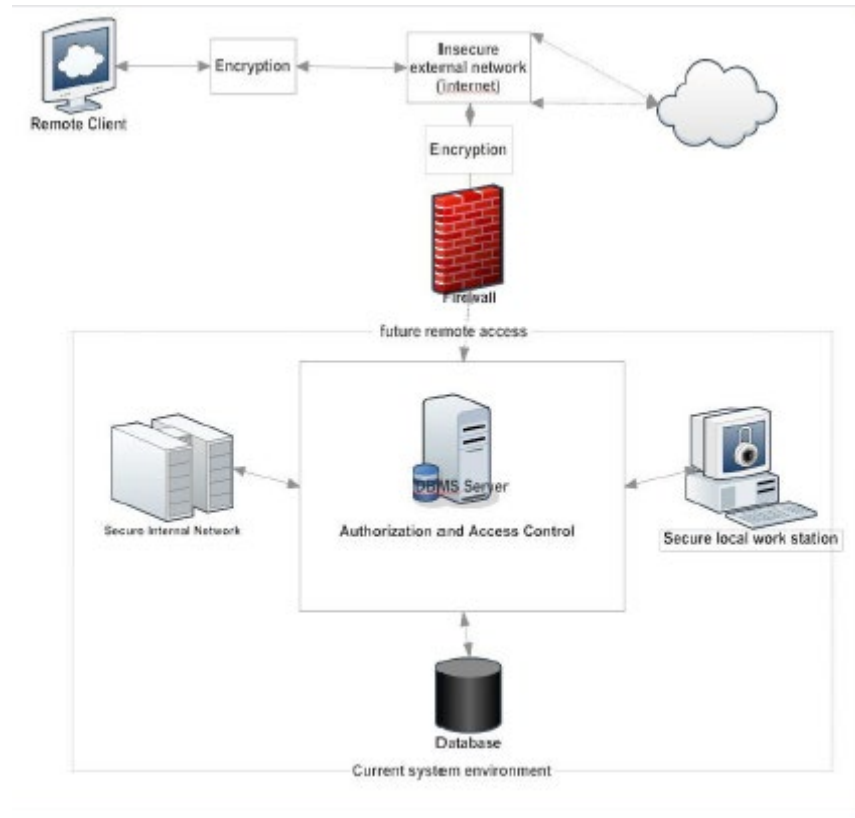
There are two types of database security generally provided by DBMSs:

The use and access of database at the system level protected by usernames and password is defined by system security mechanism.

The use and access of database objects such as relations and views and users privileges to carry out operations on these objects is defined by data security mechanism.

Database security threats

The effective implementation of security requires identification of security breach and threats. The following are the identified threats:



Users' system environment

The range of computer-based controls that are provided in a DBMS is only as good as that of the operating system owing to their close system. The figure 13 represents a multi-user computer system environment of the company. Here the designee of computer-based security system that will be implemented in user's system environment is described.

Authentication and authorization

The mechanism to check whether a user is the person who he or she claims to be is known as user authentication. The system admin is responsible for allowing staff to have access to the system. The staff is identified with a unique identifier, and with each identifier is a password chosen by the user. The identifier will authenticate the staff to user the computer system. The DBMS login identifier and workstation identifier must be same, but this also depends on the DBMS company decides to use.

The process of granting certain rights and privilege to the user that enables them to have legitimate access to a system or system object is authorization. The authorization controls are built into the software and it governs what users can access and how they can access. The process of authorization involves authentication of user and their privileges on database table, view, procedure, trigger or any other object that is created within the system. The following table 6 shows the authentication and authorization log file system

Overview of the project work

The aim of this project work was to produce a clear and good conceptual and logical data model. The objective of the project was to produce a database design based on the company's working environment. The data requirements of company were studied using the documents produced in their day-to-day business life.

Problems faced

During the project work, the most hectic problems were to study piles of documents stored in paper format. Documents were not stored in any kind of orders, neither chronological nor alphabetical. Most of the time was consumed in understanding the business and types and amounts of data generated every day.

The other problem faced was conducting staff interviews. The questions to be asked needed to be structured according to the job description. Every question answered by different staff member was different according to their own problems and issues and their way of solving them. Summarizing those answers identifying entities and relations was not easy, either.

Preparation and collecting specifications

During the project work, lots of studies were needed to complete the task, to structure the designing methods, from those studies and my earlier studies in the subject matter, and now applying them in real work gave me more knowledge in database designing. Getting knowledge is no project outcome, but is accepted (same content)

The challenges I faced during the project work have increased my confidence on tackling challenges that I may face during my work life in the same field. The time management was one of the greatest challenges during the project work. The time that I had for the project was very. Managing the time for studies, planning the project work,

and starting to do the work was very challenging. Although I believe I have finished my project work on time, I still have the feeling that I could have done it better and sooner if I would have had all the time that I thought I would need.

The process of communication with the company for which I was doing my project work has helped me develop good communication skills. Studying the business documents, interviewing the company staff, and observing the company day-to-day operations has made my business understanding very good. It was a privilege to be able to see inside

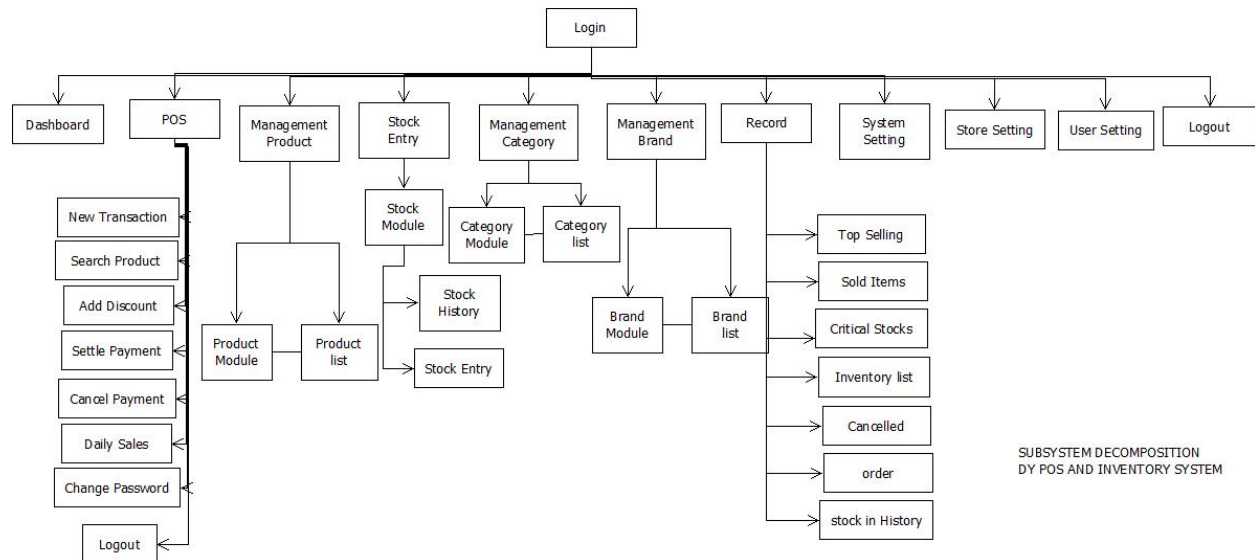
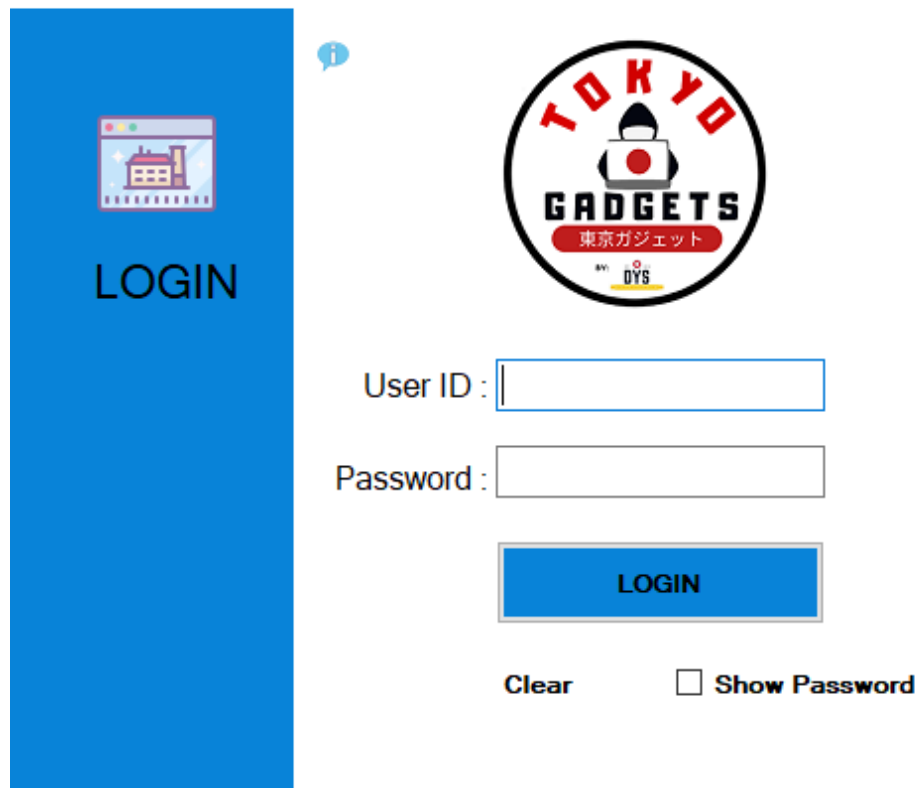




Figure no 4: Subsystem Decomposition



The login screen features a blue sidebar on the left with a factory icon and the word "LOGIN". The main area has a circular logo for "TOKYO GADGETS" with a Japanese flag and "東京ガジェット" text. Below the logo are input fields for "User ID" and "Password", a blue "LOGIN" button, and a "Clear" button. A "Show Password" checkbox is also present.



LOGIN



User ID :

Password :

LOGIN

Clear ☐ **Show Password**

Figure no 5: Login Screen


User Registration

First Name :

Last Name :


Middle Name :


Age :

Birth Day: Sunday , June 20, 2021 

Address :

Mobile# :

Joined Date : Sunday , June 20, 2021 



Insert Photo

Cancel **Next**

Figure no 6: Registration

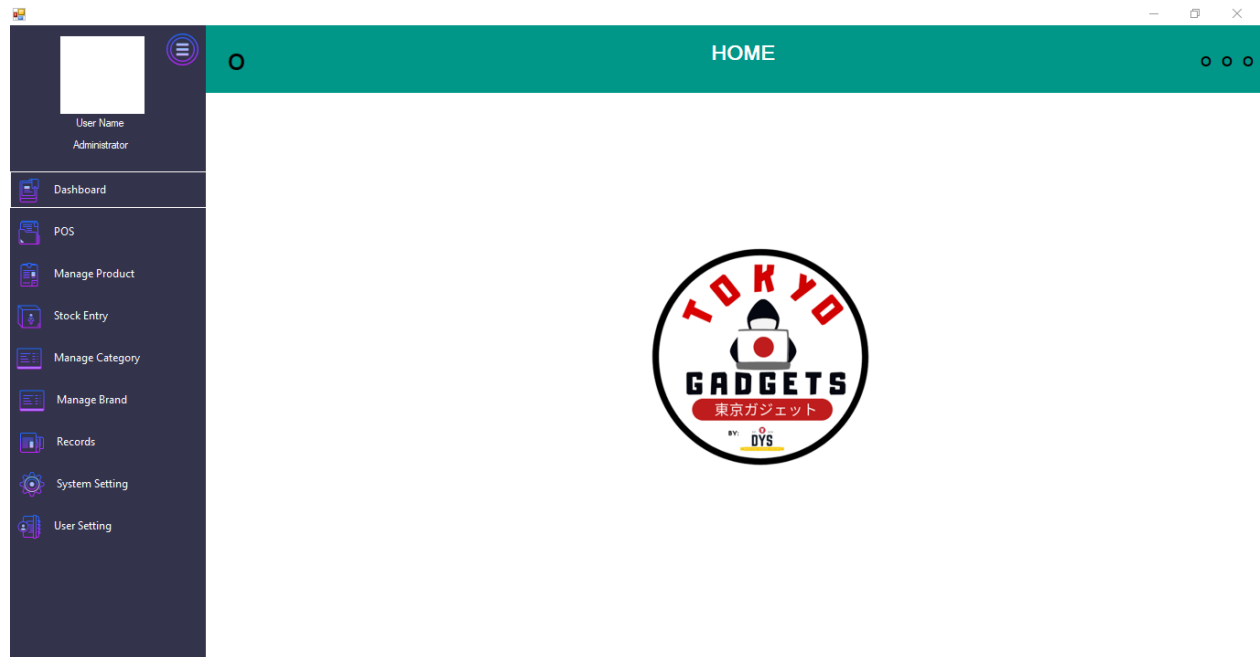


Figure no 7:Home Menu

#	PCODE	DESCRIPTION	BRAND	CATEGORY	PRICE	QTY
1	P0001	20W power adapter	IPHONE	TABLETS/COVERS	550.00	156
2	01111256	20W power adpter	IPHONE	TABLETS/COVERS	550.00	50
3	1000001	laptop core i5 gen 2 acer	ACER	EARPHONE/HEADPHONES	18000.00	2
4	P0002	U19 earphone	REALME	OTHERS	100.00	20

Figure no 8:Manage Product input/view/delete

Product Module

Product Code :

Description :

Brand :

Category :

Price :

Qty :

Save

Update

Cancel

Figure no 9:Module Product

User Name

Administrator

Dashboard

POS

Manage Product

Stock Entry

Manage Category

Manage Brand

Records

System Setting

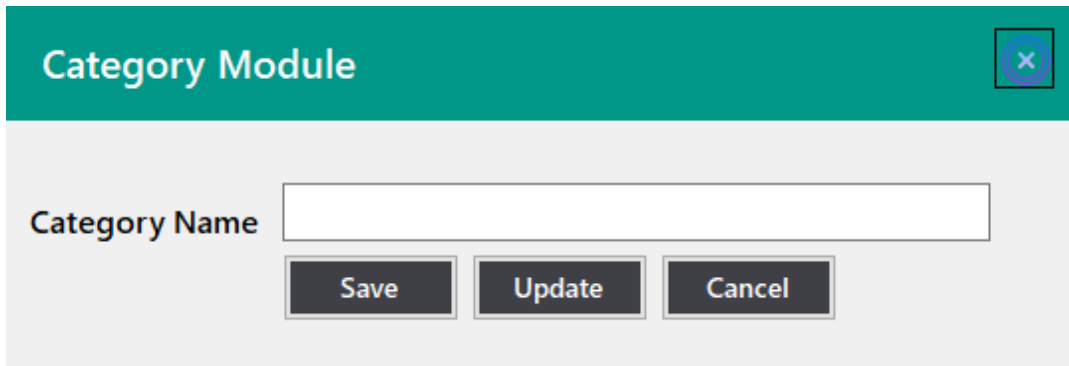
User Setting

HOME

Category List

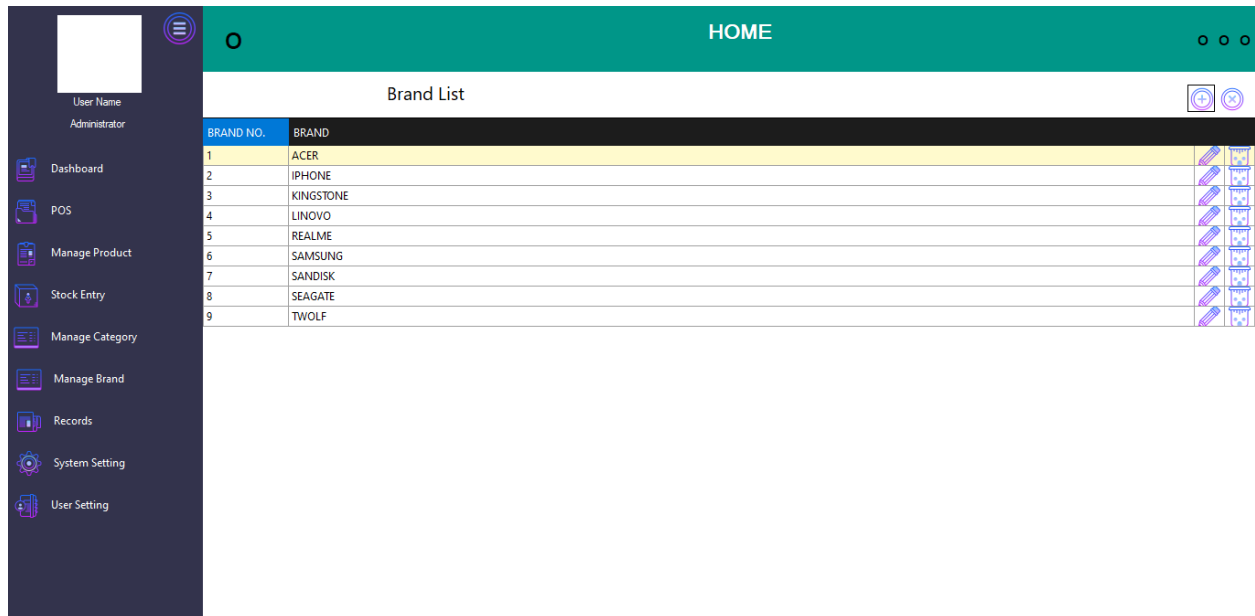
CATEGORY NO.	CATEGORY	
1	ACCESSORIES	
2	ADAPTOR	
3	BAGS	
4	CELLPHONE STAND	
5	CONNECTOR	
6	CONNECTOR/ADAPTOR	
7	EARPHONE/	
8	EARPHONE/HEADPHONES	
9	FLASHDRIVE/SD CARD	
10	HEADPHONE/EARPHONE	
11	KEYBOARD	
12	KEYBOARD	
13	LAPTOP	
14	laptop	
15	MOUSE	
16	MOUSE	
17	MOUSEPAD/DESKTOP MAT	
18	MOUSEPAD/DESKTOP MAT	
19	OTHERS	
20	OTHERS	
21	POWERBANK	
22	RINGLIGHTS	
23	SPEAKER	

Figure no 10:Manage Category



The image shows a 'Category Module' form. It has a teal header bar with the title 'Category Module' and a close button (X icon). Below the header, there is a label 'Category Name' followed by a text input field. Underneath the input field are three buttons: 'Save', 'Update', and 'Cancel'.

Figure no 11:Module Category



The image shows a 'Module Category' interface. It has a teal header bar with the title 'HOME' and a close button (X icon). Below the header, there is a label 'Brand List' followed by a table. The table has two columns: 'BRAND NO.' and 'BRAND'. The table contains 9 rows of data. To the right of the table, there are two icons: a download icon and a refresh icon.

BRAND NO.	BRAND
1	ACER
2	IPHONE
3	KINGSTONE
4	LINVO
5	REALME
6	SAMSUNG
7	SANDISK
8	SEAGATE
9	TWOLF

Figure no 12:Manage Brand

Brand Module

Brand Name

Save

Update

Cancel

Figure no 13:Module Brand

User Name

Administrator

Dashboard

POS

Manage Product

Stock Entry

Manage Category

Manage Brand

Records

System Setting

User Setting

HOME

Stock Module

Stock Entry

Stock In History

Stock In Details

Reference No:

Stock in By:

Stock Date

Saturday June 19, 2021

[Click here to Browser Product](#)

#	REFERENCE #	PCODE	DESCRIPTION	QTY	STOCK IN DATE!	STOCK IN BY	STATUS

Save

Figure no 14:Stock Module

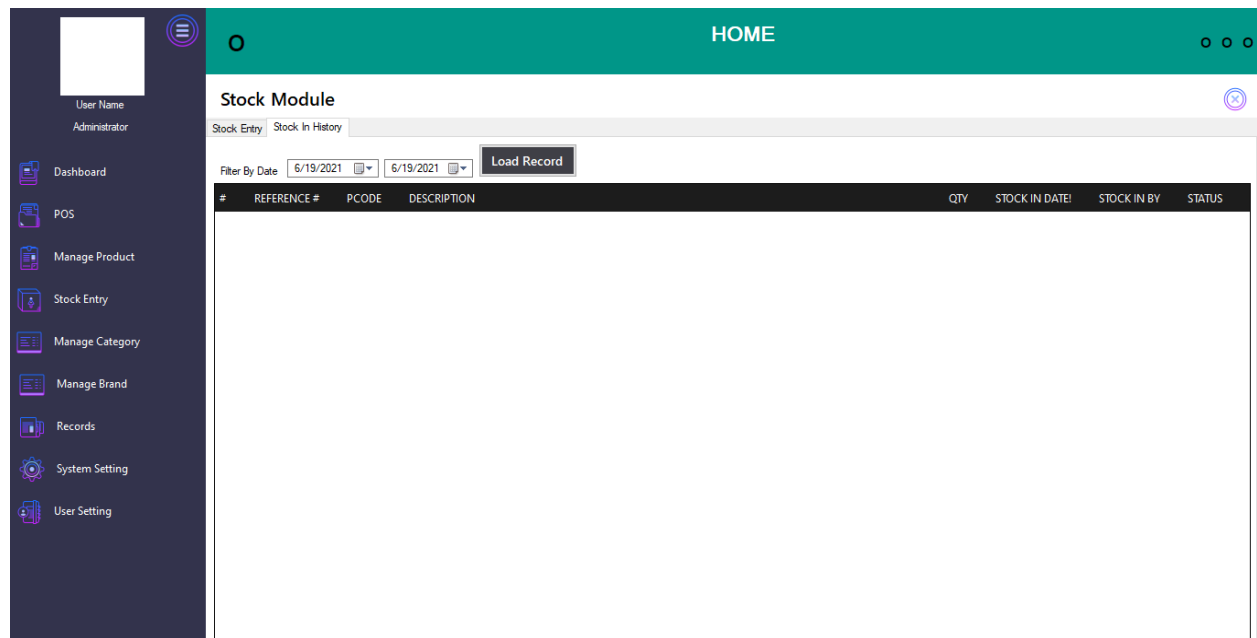


Figure no 15:Stock History

Product List				
#	PCODE	DESCRIPTION	QTY	
1	P0001	20W power adapter	156	✓
2	01111256	20W power adpter	50	✓
3	1000001	laptop core i5 gen 2 acer	2	✓
4	P0002	U19 earphone	20	✓

Figure no 16:Product List

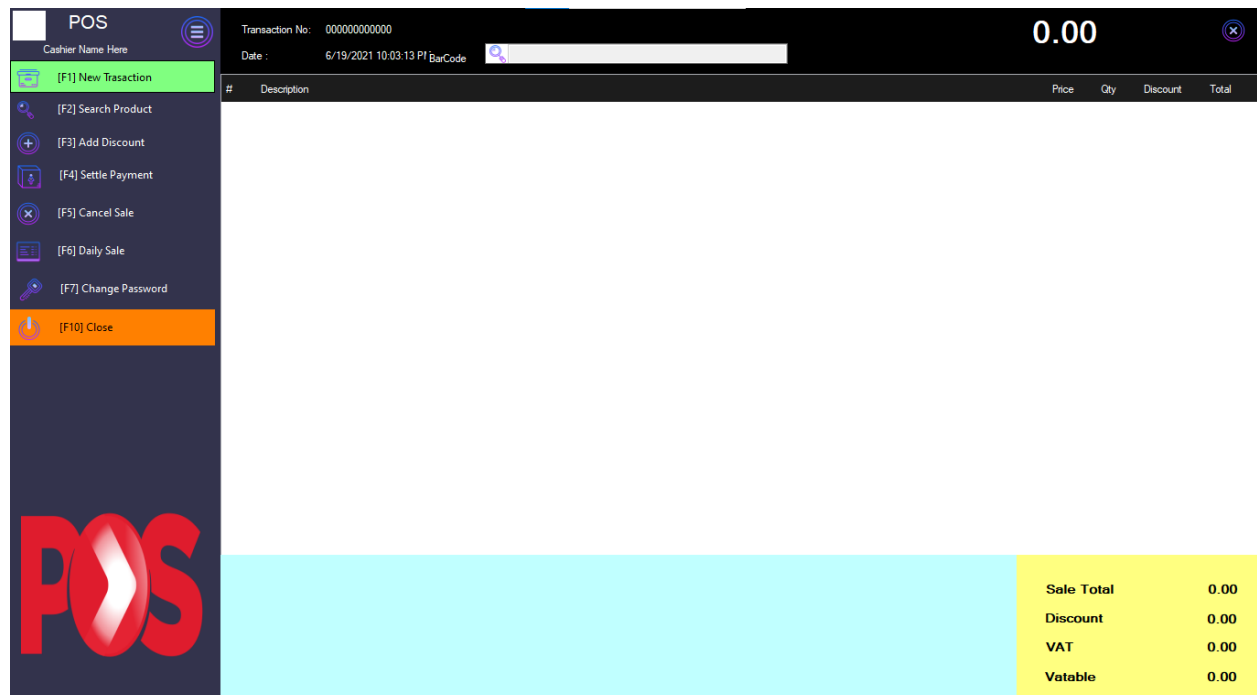


Figure no 17:POS Menu

Summary

The logical data model that has been produced during the project is fully capable of defining the data requirements of the enterprise. During the project work, all the data requirements, functional requirements, and transaction requirements were closely observed and described in this document. The document produced now is ready for the physical implementation of the SIM database system.

During the project work, the data dictionary, ER diagrams, conceptual data model, high level transaction details, data flow diagrams and logical data model were produced, which are starting point for the physical database design and implementation.

The document produced from enterprise requirements collection and analysis is very useful and important for the application development.

After the enterprise chooses platforms and required hardware components and software, the project goes to the next level as illustrated in Figure 1 where the application designer will design the application and physical database and will be implemented as a Sales and Inventory Management (SIM) System.

Reference

POS history

<https://ehopper.com/articles/what-is-pos/#:~:text=History%20of%20POS.%20To%20answer%20the%20question%20%E2%80%9Cwhat,accounting%20books%20and%20also%20keep%20their%20money%20safe.>

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