

## **DATABASE DESIGN AND IMPLEMENTATION**

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### **Abstract**

Data Modelling is the act of defining and determining the data needs of an organization, the goal of the organization and also creating a data model that suits the organizational structure. It also describes the structures and the relationships between them. This research seeks to understudy what a database model is, the types of database model, what each type is all about, their advantages and disadvantages, it also compares the differences between each database model.

**Keywords:** Database, database design and implementation, Database model.

### **I INTRODUCTION**

Database is a collection of related data; database design is the arrangement of data according to a database model. The data stored and the way the data relates with one another is determined by the designer in the database design, because of this information data is then been fit in the database model. It determines the logical structure of a database and basically controls the manner data can be stored, organized and used. A practical example of a database model is the relational database model which uses tables. In this research work we are considering the four major types of the database model, history of each models, how they interact with each other in terms of the link or relationship

between them, the way data are stored in them, the advantages, disadvantages, similarities, and uses of each model in the database. The process of installing a database software to ensure its smooth running by testing it, fit in with applications, and training its users is known as database implementation. Our main focus is on database model.

### **II RELATED WORKS**

Data is important in today's world because it is used in our day-to-day activity that is from a single individual to establishments. Data is stored in a data model to make the selection and keep strong data protection. It is an operational data which is a repository of selected data that successfully answer any,

statistical, complex or analytical queries. It is used to process large amount of data faster and more efficiently; database is shared by a universally competitive environment. Data model is used for management's decision-making process by keeping a subject oriented data. Their paper talks about in detail four existing data set models like Hierarchical, network, relational and object-oriented database and does an examination to comprehend the favorable circumstances and detriments of these data set models (Rai and Singh, 2015). Data bases are fundamental piece of most present-day web and portable applications. Relational database overwhelms the market however the advancement of object-oriented databases users and developers have another choice. Object-oriented databases give various preferences over relational databases like simplicity of extensibility, custom information models, arrangement for displaying complex information structures and quicker access time, but also have some disadvantages such as having no strict standards and implementation. Object-oriented databases are gradually finding their way into data set market, particularly in the territory of enormous scope information bases, where by the long history of relational data sets keeps them alive as extreme contender. The future is by all accounts going towards object-relational databases (Alzahrani, 2016). The notions of Object-Oriented databases, Object Relational Databases and Object-Based Databases are important in today's technological growth. Their work focused on comparing of the ideas and use of the different database gave regard to regions of utilizations and highlights. They likewise introduced diverse information Models for these variations and talks about their overall strength and shortcomings (Ogunlere and Idowu, 2015). In the mid-80's Object-oriented database systems developed the prerequisites of uses past the information handling applications which were served by relational database frameworks. Their work

served looked at the achievements of object-oriented database technology, weaknesses of the object-oriented database before object-oriented database innovation can become as boundless as relational databases (Bagui,2003). Their worked looked at what hierarchical database model is all about then focuses on the short coming of the Hierarchical Database Model to compare it the Network Database Model. They therefore, went further to look at Network Database study it, found their shortcomings, then conclude that there was a need for the evolution of Relational Model (Jindal and Bali, 2012).

### **III AIM AND OBJECTIVES**

The aim of the work is to understudy the types of database model and how they work. The objectives of this research are as follows;

- To state the types of database model.
- To know what each model is.
- To state the advantages and disadvantages of each model.
- To compare each model.

### **IV DISCUSSION DATABASE MODEL**

A database model decides the sensible design of an information base and essentially decides how information can be put away, coordinated and utilized. In general, it is how a database is structured and used.

Four types of data model include:

- Hierarchical Model - Links but no cycles (hierarchy).
- Network Model - Any links supporting quick access.
- Relational Model - Data Independence.
- Object Oriented Model - Entity Abstraction.

### **HIERARCHICAL MODEL**

This model is perceived as the underlying database model shaped during the 1960s by IBM. It is a data model in which information is addressed in the tree-like structure. In this model a kid hub has just one parent yet parent hubs can have more than one youngster that is more than one parent isn't permitted. The beginning hub of the tree is known as the root hub. For the recovery of data, the entire tree is navigated beginning from the root hub. This is a one-to-numerous connections. The data in this model is kept as records which are the assortment of fields. The association of these records is done through connections and the kind of record figures out which field is contained by the record. Each field holds just one worth.

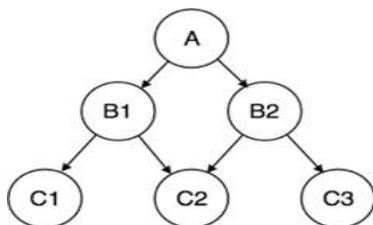


Fig 1 diagram of Hierarchical Model (source: <https://www.educba.com/hierarchical-database-model/>, 2020).

A is the root node, B1 and B2 are their child nodes, C1, C2 and C2, C3 are the children nodes of B1 and B2. Which may be directories. This is a one- to- many relationships.

Uses of the model, it is used;

- During the Mainframe Computers Era
- For putting away document frameworks and geographic data.
- In applications where elite is fundamental, for example, media communications and banking.
- For Microsoft operating system in the Windows Registry.

### Advantages

- Data can be retrieved effortlessly because of links present between the parent and child node.
- Changes made in the parent table are naturally refreshed in a youngster table which is called referential uprightness.
- Promotes data sharing.
- security is ensured in the database.
- Good with 1 to many relationships.
- There is a line of command or authority.
- It expands specialization.
- It has elite.

### Detriments.

- Adding another section is troublesome if the parent table and youngster table are inconsequential.
- This model does not support Complex relationships.
- Inaccurate information can be found due to redundancy.
- Change in design prompts change in all application programs.
- Many to many relationships is not allowed.
- No data manipulation.
- This model is not flexible
- There is a communication barrier between child and parent node.
- The structure is rigid.

### NETWORK MODEL

The network model was first uniquely designed by Charles Bachman, in 1969 it was formed into a standard determination distributed in the Conference on Data Systems Languages (CODASYL) Consortium. In 1971 the subsequent distribution was published; this was the reason for most usage. Resulting work proceeded into the mid-1980s, coming full circle in an ISO detail, however this had little impact on items. Bachman's impact is known in the term Bachman chart. In a Bachman outline, named square shapes address record

types, and bolts address one-to-numerous relationship types between records (CODASYL set sorts).

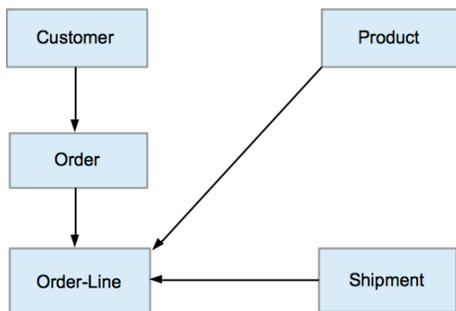


Fig 2 Bachman diagram (source: [https://en.wikipedia.org/wiki/Network\\_model](https://en.wikipedia.org/wiki/Network_model), 2020).

The network model is a continuation of the hierarchical model because it uses a tree-like structure which allows many-to-many relationships that is it has multiple parents. It representing objects and their relationships in a flexible way.

Three concepts of a network model are;

- Records contain fields which need progressive association.
- Sets are utilized to characterize one-to-numerous connections between records that contain one proprietor, numerous individuals.
- A record may go about as a proprietor in quite a few sets, and a part in quite a few sets.

A chain of command exists between any two record types where one sort (A) is the proprietor of another kind (B). Simultaneously, another set can be created where the last set (B) is the proprietor of the previous set (A). In this model, proprietorship is characterized by the course, accordingly all the sets involve an overall coordinated diagram. Admittance to records is created by the ordering construction of round connected records.

Features of a network model are;

- It shows redundancy in data more effectively than hierarchical model.
- More than one way exists from a past hub to replacement hub.
- The network model tasks are kept up by ordering construction of connected rundown where a program keeps a current position and explores starting with one record then onto the next by following the connections in which the record takes an interest.
- Records can likewise be situated by providing key qualities.

The outline shows an organization model, where a specialist addresses various customers and deals with various performers. The customer books commitment and makes installments to the specialist for their administrations. Every performer performs different commitment and plays assortments of melodic styles.

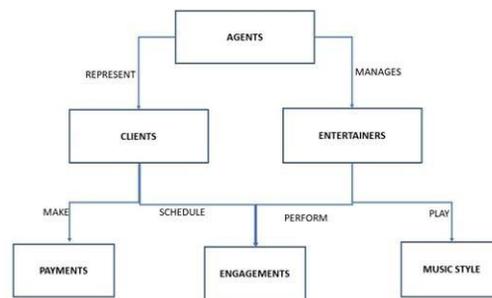


Fig 3 Network diagram (source: <https://www.tutorialspoint.com/Network-Model>, 2020).

### Advantages

- It is fast to access data because of its many-many relationship.
- Users can create queries that are more complex than those of hierarchical database.

- It is easier get information because of its flexibility.

**Disadvantages**

- The client should be utilized to the design of the information base to work through the set constructions.
- Updating the information base is a troublesome undertaking. Once in a while for you to refresh the set construction is influenced when this happens you should alter all references produced using inside the application program to that structure.

Table 1 Differences between Network Database and Hierarchical Database Model

Network Database Model	Hierarchical Database Model
There is a many-to-many relationship in this model.	Here only a One-to-many relationship exist
There is an easy accessed because of its interconnection.	It is Hard to direct because of its one-many relationship
It is flexible because it supports many to many relationships.	It is less adaptable due to the progressive situation of the documents.

**RELATIONAL DATABASE**

A relational database is made up of a collection of “relations”. The relational data model began from a man named Edgar(E.F.) Codd. He was brought into the world in 1923 in England in 1923, he relocated to the United States where the vast majority of his work on the social information model was done at the

IBM's Watson Research Center. He kicked the bucket in 2003. He died in 2003. During the 1960s, he worked with existing data models although he was trained in mathematics. He worked on the construct known as a relation. He produced the relational database model with the concept, which was introduced in a paper in 1970. In mathematical set theory, a *relation* is a table with columns (attributes) and rows (tuples).

**Constraints on Relational Integrity**

Relational Integrity constraints is denotes conditions for a relation to be valid. They are gotten from rules that represent database.

**Types of integrity constraints**

- Domain
- Key
- Referential integrity.

**Domain Constraints**

This rule specifies that the value of each attribute must be unique within each tuple. They are data types which includes; Booleans, variable length strings, integers, real numbers, characters.

**Key constraints**

A key is a unique identifier of an attribute in a tuple. In a relation, the attributes have to be unique for the value of the attribute for different tuples.

**Referential integrity constraints**

It has to do with the concept of Foreign Keys. In a relation, an important attribute is the foreign key in other relationships. When relation refers to a key attribute of a different or same relation it is referred to as Referential integrity constraint. The key element must exist in the table.

**Operations in Relational Model**

The four basic update operations performed are: Insert, update, delete and select.

- Modify allows you to change the values of some attributes in existing tuples.
- Delete is used to delete tuples from the table.
- Select allows you to choose a specific range of data.
- Insert is used to insert data into the relation

### **Advantages of using Relational model**

- It is much simpler than that of the hierarchical and network model.
- It improves the performance of the model because data is of great importance here.
- It is easy to use since it makes use of tables which comprises of rows and columns.
- It uses languages like SQL for easy navigation.
- Its structure changes without changing the application.
- Its fields are usable because they are enlarged.

### **Disadvantages of using Relational model**

- There are limitations on the length of fields.
- As the amount of data grows, relational databases become complex.
- When complex, relational database systems cannot share information.

### **Object Oriented Data Model**

Object-oriented Database Management System (ODBMS), is a model where data is stored as objects, which are instances of classes.

### **Components of Object-Oriented Data Model:**

There are three major components, namely: Object structure, Object classes, and Object identity.

#### **1 Object Structure:**

This refers to the properties that an object which is the attribute. An object is a described as an article that has attributes in the real-world. Data encapsulation is necessary in an object, because it hides or secure users' information. It has three components which are messages, methods, and variables.

#### **Messages**

This is an interface or medium of communication between an object and the outside world.

#### **Methods**

Method is the body of the code that executes a message when it is passed. An output is produced when a message is passed. It has two types:

- **Read-only method:** methods do not affect the value of a variable.
- **Update-method:** methods affect the value of a variable.

#### **Variables**

This is where the data is stored, this stored data differentiates an object from another.

#### **2 Object Classes:**

A class is an object in the real-world entity. The class needs to be defined; the objects are stored in the class which have different variables. Various messages and variables have to be the same with the object that stores the information.

#### **Example**

```
class CLERK
{ //variables
```

```
char name;  
string address;  
int id;  
int salary;  
  
//messages  
  
char get_name();  
string get_address();  
int annual_salary();  
  
};
```

The example indicates the class is CLERK which holds the object variables and messages.

object-oriented supports data encapsulation. It holds abstract data types which are the user defined data types. They hold values and have methods attached to them.

OODBMS has characteristics of both database management system and object-oriented data model. It also allows programming paradigms like data encapsulation, inheritance, abstract data types, classes and objects.

### **The Components of the Object-Oriented Data Model**

- it is related to entity-relationship model because an object is a notion of a real-world entity.
- the properties of an object are described as an attribute define. For example, a CLASS object includes the attributes Name, class ID, year, semester.
- Classes are objects of similar features are grouped together. It is a collection of similar objects such as attributes and methods. However, a class contains methods.

- Classes are arranged in order of hierarchy. The class hierarchy looks like an upside-down tree in which each class has only one parent. For example, the CLASS ID class and the COURSES class share a parent STUDENT class.

- objects have the ability to inherit attributes and methods of the classes above it. For example, two classes, CLASS ID and COURSES, can be created as subclasses from the class STUDENT. In this case, CLASS ID and COURSES will inherit all attributes and methods from STUDENT.

### **Advantages**

- Different types of data can be sorted with object database unlike the others. Examples of such categories of data are pictures, voice video, including text, numbers and so on. Both object database and relational database handles data differently.
- Code reusability, a well improved reliable, flexible, and real-world modelling systems can be achieved in an object-oriented database.
- There is minimal maintenance cost of object-oriented database when compared to others. This is because it encourages system encapsulation. Which can be reused and incorporated to achieve new tasks.

### **Disadvantages of Object-Oriented Data Model**

- OODBMS do not have a general defined data model.
- OODBMS is rather restricted than that of RDBMS because it is not widely accepted.
- This database model mechanisms for security are inadequate.
- Compared to other database models, the complexity of OODBM is more.

Table 2 Shows below is the difference between relation and object-oriented database model.

<b>Object-Oriented Model</b>	<b>Relational Model</b>
It uses class	It uses tables or relation
Object is used to store real-world entities.	It uses records or tuple
Data is stored as variables.	It is stored as attributes or column
It uses methods to executes messages	It uses stored procedures.

## V CONCLUSION

This research work focused on the different types of database models, their history, advantages, and disadvantages. We looked at four major types which are Hierarchical Model - Links but no cycles (hierarchy), Network Model - Any links supporting quick access, Relational Model - Data Independence and Object-Oriented Model - Entity Abstraction and their constraints.

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