NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

LABORATORY MANUAL

CZ2007: Introduction to Databases

Software Lab 2 (Location: N4-01c-06)

or

Software Lab 3 (Location: N4-B1c-14)

Implementation of a Database Application

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
NANYANG TECHNOLOGICAL UNIVERSITY

1. OBJECTIVES

Upon completion of the assignment, the student should be able to:

a. Construct an entity-relationship model at a conceptual level
b. Map the model into a schema of a relational DBMS
c. Implement the given schema on a relational DBMS
d. Use a database language (SQL) for manipulating and updating data

2. LABORATORY

This is a group assignment. Each group consists of **four to five** members from your laboratory group. You have the choice of selecting your group members. However, all the names within your group must be given to the laboratory technician(s) during your first laboratory session. Name lists with respect to each laboratory group are available in the "Public Folders" towards the beginning of the semester.

Note that the laboratory will start from the **third week** of the semester onwards and that you might need more than the mentioned five sessions for the actual implementation. You are also encouraged to **start early** with your assignment (as soon as the topic is covered in the lectures).

Attendance is taken for all supervised laboratory sessions. It is the responsibility of each student to sign-in at the beginning of each session. **Failing to sign-in for the first, third, or fifth lab session may result in a F grade for the respective assessment.**

3. INTRODUCTION

The assignment covers the portion of the course concerning data modelling, database design and implementation from the user's viewpoint. Thus, the assignment involves modelling as well as implementation aspects of the database course.

The overall aim of the laboratory is to develop an application based on a given data model using a given database management system. This exercise will bring you through a crucial first part of the life cycle of a database application. It is assumed that the data analysis has been performed. Note that this manual provides you with more information than is required for the first laboratory session; e.g., not all constraints can be modelled in the beginning but are included at a later implementation stage. In contrast you might require additional information for the understanding of the application. Proceed by stating your assumptions in written form and / or ask your laboratory supervisor.

4. DESCRIPTION OF THE ASSIGNMENT

The description of the application is given in the appendices. This includes the back-ground and general requirements of the application, conceptual information about the system and its users as well as a list of queries that must be fulfilled as a minimum.

Note that teamwork is required. Every team has to submit one solution. **No individual submission will be accepted.**

4.1 First Laboratory Session: Creating an ER Diagram

Appendix A gives conceptual information about the project obtained after a partial sys-tem analysis was performed. Based on the appendices, construct a suitable ER diagram. Analyse the cardinality of relationships, the usage of weak entity sets, choice of entity sets etc. and compare them with alternative solutions. The laboratory technicians will provide the necessary information at the beginning of the lab session.

You need to submit the followings at latest **three working days** after the first laboratory session.

- A hard copy of your ER diagram and written discussion of your solution (maximum one page), which highlights the reasons for the chosen design.

4.2 Second Laboratory Session: Finalization of the ER Diagram

There is no submission for the second laboratory session. In this lab, each group should finalize their database design based on the feedback received from their lab supervisor. Please note that the second laboratory session is a free-access session; i.e., attendance is not compulsory (but recommended in case the group has questions).

4.3 Third Laboratory Session: Generation of Normalized Database Schema

In this lab you must ensure that the database is at least in 3NF. Follow the general guide-lines covered during the lectures and tutorials to produce suitable normalized relations. For each relation, the key(s), primary key, and functional dependencies must be specified. If a relation is generated due to normalization of an original relation, then the normalization steps must be presented.

You need to submit the followings at latest **three working days** after the third laboratory session.

- A hardcopy of the normalized database schema and FDs associated with each relation. If a relation created from the ER diagram violates the 3NF form then this should be highlighted along with the decomposed normalized relations. Note that for this lab no SQL code should be submitted. Hence, the structure of your solution shall be similar to the following example:

  R1(A, B, C, D)

  Keys: AB, AD
  Primary Key: AB
  FDs: AB → CD, A → D
  The relation is in 3NF.

4.4 Fourth Laboratory Session: Implementation of the database schema

There is no submission for the third laboratory session. In this lab, the finalized database schema must be implemented using SQL DDL commands. Your implementation should clearly incorporate the primary and foreign keys, data types, integrity constraints, value-based and tuple-based constraints. Solve the implementation by using the MS SQL Server software.

Please note that the fourth laboratory session is a free-access session, i.e., attendance is not compulsory (but recommended in case the group has questions).

4.5 Fifth Laboratory Session: Final demonstration

The fifth session is the final assessment of your implementation. The implementation obtained from the previous laboratory session has to be extended by incorporating necessary triggers and additional constraints. In addition, you have to formulate the SQL statements for the sample queries in Appendix B.

This session has two components. First, **at the beginning of the lab** a hardcopy of the schema implemented using the SQL DDL commands together with constraints and sample queries need to be submitted. Auto-generated relations are not permitted. Hence, the structure of your solution for the database schema definition shall be similar to the following example and written by yourselves:

```
CREATE TABLE name (
        attr1 datatype NOT NULL,
        attr2 datatype,
        ...
        PRIMARY KEY (attr1),
        FOREIGN KEY (attr3) REFERENCES name(attr1)
                ON DELETE ... ON UPDATE ...,
);
```

The second component of this session involves **demonstration** of your system. All team members are required to contribute actively during the demonstration session. Additionally, the laboratory supervisor will ask individual questions. During the demo session, the evaluation shall be based on the following points:

- Implementation and execution of additional queries on the spot
- Answers on and understanding of the design and related issues
- Demonstration of the proper working of your implementation
- Additional effort in terms of implementation etc.
- Presentation quality

Note that your group might be required to begin the presentation at any time during the fifth laboratory session; i.e., one team will be asked to present at the beginning of the session. All applications should run on the provided hardware and software components of the Software Laboratory 2 using MS SQL Server.

APPENDIX A

AliMaMa is an online shopping website. Suppose that you are to construct a database for AliMaMa, and the requirements are as follows:

- The site hosts a number of shops, each of which has a unique name. Each shop sells a number of products, each of which has a name, a category, a maker, a price, and a number in stock.

- One product could be sold at multiple shops at difference prices. In addition, the price of a product in a shop may change over time.

- AliMaMa allows users to place orders from the shops. Each user has an ID number and a name. Each order has a timestamp. Each order involves one or more products, which could be from different shops. For each product involved in an order, its price and quantity are recorded. Each order has a total shipping cost and a shipping address.

- After an order is made, the user can track the status of the order on AliMaMa. Initially, the status of each product in the order is shown to be "being processed". After the shop (that sells the product) ships the product, the status of the product will be changed to "shipped". Once a product is delivered to the user (as reported by the courier), the status of the product is changed to "delivered", and the delivery date is recorded. Within 30 days from the delivery date of a product, the user may return the product for a refund. Once the shop refunds the product, its status will be changed to "returned".

- After a user purchases a product, he/she is allowed to rate and comment on the product once. There are five possible ratings: 1, 2, 3, 4, and 5, with 5 being the highest. The average rating for a product, as well as the number of users that have rated the product, are shown on the web page that displays the product information to the users. In addition, a user can modify his/her ratings and comments anytime. Furthermore, a user can also comment on other users' comments.

- AliMaMa users are allowed to file various complaints. In particular, if a user does not receive a product that has been shown to be "delivered" in an order, he/she can file a complaint to AliMaMa. If he/she is not happy about a certain shop, he/she can file a complaint. If he/she finds that a certain user comment (on a product) is spam or uses abusive language, he/she can file a complaint. After a complaint is filed, the user can check the status of his/her complaint. Initially, the status of the complaint is set to "pending". After the complaint is picked up by a AliMaMa employee, the status is changed to "being handled", and the name of the employee is shown. Once the complaint is addressed, its status is changed to "addressed".

- AliMaMa has a number of employees that handles complaints from users. Each employee has an ID, a name, and a monthly salary. Each complaint is handled by one employee.

- The database should support the queries listed in Appendix B.

Note that the provided information may not be complete. Many aspects of the system's functions and details may have been omitted. It is expected that the teams come up with their own solutions in case of inconsistencies or missing information. However, you have to keep track of these aspects and explain your assumptions if asked for the reasons. Extensions to the implementation of the basic system are encouraged.

APPENDIX B

Queries

1. Queries 1. Find the average price of “iPhone Xs” on AliMaMa from 1 August 2018 to 31 August 2018.
2. Find the products that receive at least 100 ratings of “5” in August 2018, and order them by their average ratings.
3. For all products purchased in June 2018 that were delivered, find the average time from the ordering date to the delivery date.
4. Let us define the “latency” of an employee by the average that he/she takes to process a complaint. Find the employee with the smallest latency.
5. Produce a list that contains (i) all products made by Samsung, and (ii) for each of them, the number of shops on AliMaMa that sell the product.