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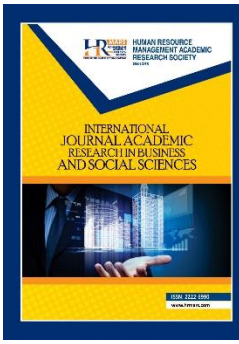
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ABSTRACT

This paper focuses on steps to develop an Entity Relational Model (ERM) using a case study of Human Resource Training Management (HRTM) in an organization. It is designed and written to help students learn the process to create a conceptual model by working through the HRTM business activities. ERM represented by Entity Relationship Diagram (ERD), and Chen's notation being used to illustrate the graphical ERD representation. The following steps which involved are: ((1) Identify, analyze and refine the business rules which involved studying the business activities, gather the information and discover the data elements by identifying the information: needs, users, sources and constitution (2) Identify the main entities (3) Define the relationships among the entities, (4) Complete the initial ERD. Each step is explained and accompanied by examples and diagrams to illustrate the process.

Keyword: Entity Relationship Diagram (ERD), Conceptual Model, Human Resource Training Management (HRTM), Chen's Notation and, Information Management.

INTRODUCTION

Database design is an important component of the curriculum in business and information management. In introduction to database, students must understand the basic of database design as well as the approach and techniques used by a database designer to communicate with the users in order to understand their needs. Database design consists of four primary phases: requirements specification, conceptual design, logical design, and physical design. In requirements specification phase, user needs are gathered through a process of collecting data from users and existing systems, and from available documentation to determine database design specification. The requirements document can be analyzed and turned into a basic data set which can be converted into a conceptual model. Hence, in the second phase, conceptual design involves the process of transferring user requirements to a specific graphical data model. A data model is represented in a diagram which is used to present the data requirements at

different levels of abstraction (Rob & Coronel, 2007) and the most commonly used modeling technique for relational databases is the Entity Relationship (ER) modeling. Logical design is the process of translating the ER diagram into a set of tables. The initial step in logical design is to represent the entities, attributes, and relationships found in the ER diagram into a set of related tables. The second step is to transform the tables to remove duplication of data using a process called normalization (Codd, 1970). On the other hand, physical design is the process of specifying database parameters such as data type and field length, then implementing the design in a specific relational database management system. This paper gives more focus on the second phase: conceptual design.

LITERATURE REVIEW

Students learning to create conceptual data models from written descriptions and communications are sometimes confusing by the fact that they can develop several alternative ER models to represent the same situation. Interpreting the user requirements that lead to conceptual data models can be very subjective. Students studying ER modeling technique are also expected to make suitable assumptions to create models to represent a business context. Research involving ER modeling has focused on certain ER modeling principles and notations. However, reasons to why some are able to create ER models from communications and written descriptions fairly easily while others find it difficult are not discussed (Bodart et al., 2001). Connolly & Begg (2002) state that to gain an understanding of the nature of the data and how it is used by an organization, a model for communication that does not involve technical discussion is necessary. Kimball (1997) states that ER modeling is a regulation used to represent associations among data and is focused on removing data redundancy more often than to create databases that can be queried efficiently.

ER modeling is still one of the popular approaches for teaching conceptual modeling and therefore, the purpose of this paper is to assist students to create conceptual data models from written and verbal descriptions using ER diagrams. In the conceptual design stage, the conceptual model must embody a clear understanding of the business and its functional areas. ER models have a layered approach to organizing information, in that the basic components of an ER model: entities, attributes, and relationships can only be combined in certain ways (Chen, 1976). The approach to design a conceptual model using ER diagram that is used in this paper refers to the approach presented in Coronel and Morris (2015). Developing a conceptual model using an ER diagram consists of the following steps: (1) Identify, analyze and refine the business rules, (2) Identify the main entities, (3) Define the relationships among the entities, (4) Complete the initial ER Diagram

In the following paragraphs, the first step in developing a conceptual model using an ER diagram, i.e. identify, analyze and refine the business rules, is explained.

GATHERING BUSINESS RULES

As previously mentioned, the first step is to identify, analyze, and refine business rules. According to Rob & Coronel (2007), business rule is a brief, precise and unambiguous description of a policy, procedure or principle within a specific organization. Business rules are derived from a detailed description of an organization operation. A detail description of operation can be found during

database initial study phase by analyzing the company situation. The database designer (DD) can gather the information by doing some interviews and document survey at the company. The staff who is involved in the systems (i.e. during the input, process, output, and feedback) and the staff who are involved in decision making must be identified and interviewed to get the detail of company operations, inclusive of: manual or computerized operations, business functions, events, policies, units, stakeholders, their relationships, the business rules, and the relevant documents or forms. Documents such as the company procedures, standards, annual reports, work orders, job descriptions, organization chart, desk files, and operations and systems manuals must also be analyzed by the DD. It is recommended that the findings are gathered and kept in a written format and are updated to reflect any changes in the operations environment. The information must be written clearly and must be widely disseminated to ensure that every staff in the organization shares a common understanding of the rules.

DD must identify the following: (1) what kind of information is needed, (2) who will use the information, (3) where the information is located, and (4) what data elements are needed to produce the information. In order to identify them, the necessary information can be obtained by the following: (1) developing and gathering end-user data views, (2) directly observing the current system: existing and desired output, and (3) interfacing with the system design group. Knowing the business rules enables the DD to understand fully how the business works and what role the data plays within the company operations. The business rules prepare for the proper identification of entities, attributes, relationships and constraints. As stated by Rob and Coronel (2007), a noun in a business rule will translate into an entity in the model, and a verb associating nouns will translate into a relationship among the entities. The relationships must be considered as bidirectional which can go both ways.

The process to create a conceptual model will be illustrated by working through the following case study.

IMPLEMENTATION: CASE STUDY HRTM

ABC is an organization which deals with record and information activities. To ensure every staff has the necessary knowledge and skills to improve its services, the top management has developed set a policy where every staff must attend courses for at least seven days per year. There are many courses offered by several agencies. The staff can select any of the courses or the Head of Department will select the relevant courses for them. An application form to apply for the course must be sent to the Training Unit at least one month before the course starts, using the course application form.

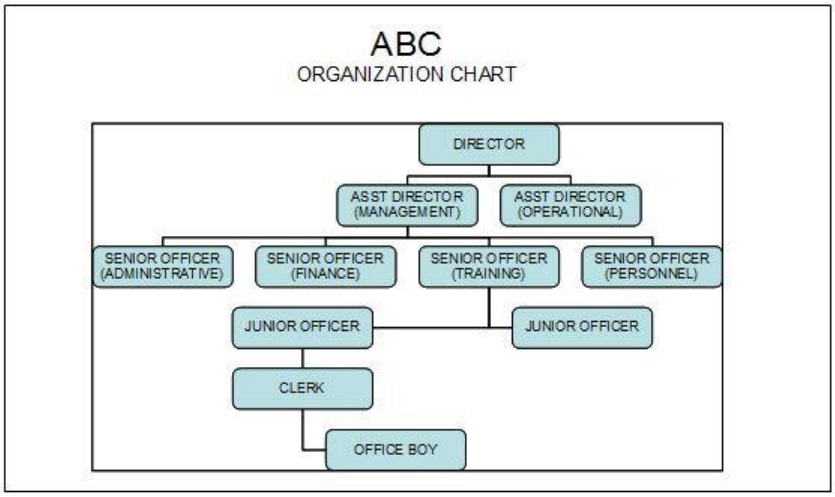


Figure 1: ABC Organization Chart

Currently, the Training Unit manages the training activities. This unit is directly under the company director and is lead by a senior officer (Figure 1). The other supporting staff include a clerk, two junior officers and an office boy. The Training Unit is currently using manual systems in their day to day operation that consist of letters, files and record books. However, they always refer to one of the company information systems available to search for staff details. Once the Training Unit has received the courses offer letters from the agencies, the Training Unit will distribute them to the respective departments to get candidates. If any of the staff are interested to attend any of the courses, they can apply manually using an application form obtained from their Head of Department. The Training Unit will then process the applications and then send a letter to the staff who will be attending the course.

Every middle and end of the year, the Training Unit must prepare a report on courses information and staff training attendance to submit to the top management and Headquarters. The most important information that they need is: how many staff have attended the courses based on (1) the staff's position, (2) their departments, (3) the dates and (4) the courses they attended. They would also like to know the number of staff who do not attend any course for at least 7 days per year.

The top management uses the information in their planning for staff development; and by having the reporting done manually, it is very difficult for the Training Unit to produce these reports in a timely manner. Due to this, the IT Unit has been requested by the head of the Training Unit to develop a database system to automate the process.

In the next sections, the steps used by the DD from the IT Unit to create the conceptual model based on the information given above are discussed.

STEP 1: IDENTIFY, ANALYZE AND REFINE THE BUSINESS RULES

The organization chart in Figure 1 shows that the Department of Management consists of Administrative, Finance, Personnel and Training Unit. It also shows the positions of staff at the Training Unit.

A summary of business activities is as follows:

- Every staff must attend any course for at least 7 days per yea
- There are many courses offered by several agencies
- Training Unit will receive courses offer letters from the training agencies
- The offer letters will be circulated to other departments to get candidates for the training (staff who is interested to attend)
- The staff can apply for any course through the Head of Department and get the approval before sending the application form to the Training Unit
- The Head of Department can also appoint any staff to attend any of the courses offered by the agencies
- The application form must be sent to the Training Unit at least one month before the course starts using a course application form
- Training Unit will process the applications and will send a letter to the staff who will be attending the course
- The documents involved in the day to day operation are letters, files and record books
- Training Unit refers to an automated system to search the staff details
- A report on courses and staff training must be prepared in every middle and at the end of the year.
- The report must contain information on a total number of staff and a list of staff who have attended courses based on (1) the staff's position, (2) their departments, (3) the dates and (4) the courses they attended, and a total number of staff and a list of staff who have not attended courses for at least 7 days per year.

Some of the information collected by the DD based on the above input are grouped together accordingly as shown below:

Table 1: Gathering Information

1	**What kind of information is needed?**	▪ Course information ▪ Staff information ▪ Agencies information ▪ Course attended by the staff ▪ Course offered by the agencies
2	**Who will use the information?**	▪ Staff at Training Unit ▪ Top management ▪ Staff at the agency
3	**Where is the information obtained?**	▪ At Training Unit ▪ Brochures / Letters / Courses Modules from agencies to Training Unit ▪ Offer letters from Training Unit to the Head of Department informing the available courses ▪ Application forms from staff to Training Unit ▪ Letter of offer to attend courses from Training Unit to staff ▪ An automated system which contains staff personal details ▪ Half and yearly training information report ▪ Log book / Registration book (letters coming in and out)
4	What data elements are needed to produce the information?	▪ **STAFF** -> name, position, department, phone number, staff number, date employed, date of birth, staff skill ▪ **COURSE** -> course name, course code, course start date, course end date, agency, course skill ▪ **AGENCY** -> agency code, agency name, address, phone number ▪ **COURSE OFFER DETAILS** -> course details, agency details, offer date, offer reference ▪ **APPLICATION DETAILS** -> staff details, course details, application date, application references ▪ **ATTEND DETAILS** -> staff details, course details, attend date, attend reference
5	Business Rules	▪ One or many courses offered by one or many agencies ▪ One or many staff can apply for one or many courses ▪ One or many staff can attend one or many courses

STEP 2: IDENTIFY THE MAIN ENTITIES

As already mentioned, a noun in a business rule can be translated into an entity in the model, and hence, based on the information **no.1** and information **no.5** from **Table 1**, three (3) main entities have been identified.

ENTITIES

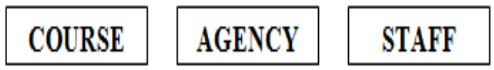


Figure 2: Entities

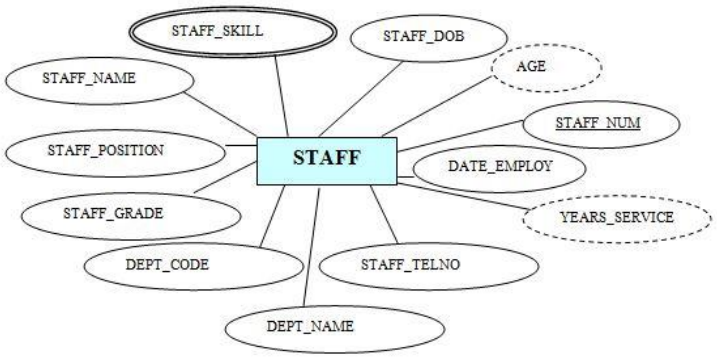
ENTITIES AND ATTRIBUTES

Attributes of an entity also means characteristics of an entity. Some of the attributes or characteristics of **STAFF** entity are: staff number, staff name, staff position, staff phone number, and so on. The DD should choose only relevant characteristics or attributes to be included in the design. The DD can always add or remove attributes of an entity to modify and improve the design later. The attributes of STAFF entity has been identified, as shown below:

STAFF -> staff_num, staff_name, staff_dob, staff_skill, staff_position, staff_grade,
dept_code, dept_name, staff_telno, date_employ, age, years_service

Once the attributes of an entity have been identified, the DD must choose the most appropriate attribute(s) as the primary key (PK) of a particular entity. This is important in the logical design phase when the DD begins to create tables and relationships. An entity can be regarded as a table in logical design phase.

A PK will uniquely identify any given row in a table and a PK cannot contain a NULL value. For example, staff_num can be a PK of table STAFF because staff_num can uniquely identify only one particular employee and there are no other employees who share the same staff_num. Furthermore, each staff has his or her own staff_num and this means that staff_num cannot be NULL. Hence, staff_num in table STAFF can be identified as a PK. Similarly, staff_IC_number can uniquely identify only one particular employee and it cannot be NULL. Furthermore, there are no other employees who share the same staff_IC_number. Hence, staff_IC_number in table STAFF can be identified as a PK. With few possible PKs identified, the DD must then choose the most appropriate attribute to be used as the primary key of the particular table (or entity). In this example, the DD has selected staff_num, and staff_num is underlined in the diagram to denote it as the PK.



STAFF -> STAFF_NUM, STAFF_NAME, STAFF_DOB, STAFF_SKILL, STAFF_POSITION, STAFF_GRADE
DEPT_CODE, DEPT_NAME, STAFF_TELNO, DATE_EMPLOY, AGE, YEARS_SERVICE

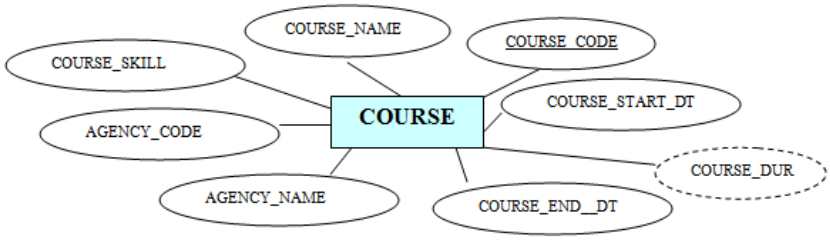
Figure 3: Staff

STAFF_SKILL is an example of a **multivalued attribute**, i.e. one staff may have many skills, depending on the courses that he or she attended.

AGE is an example of a **derived attribute**, i.e. the value can be calculated (or derived) from CURRENT DATE (SYSTEM DATE) – STAFF_DOB.

YEARS_SERVICE is an example of **derived attribute,** where the value is calculated (derived) from CURRENT DATE (SYSTEM DATE) – YEAR of DATE EMPLOY

Point to note:
For each entity or table, a PK can consist of only one attribute (PK) or a combination of attributes (in this case, it is called a composite primary key or a CPK). The objective is to find an attribute or a combination of attributes that can uniquely identify any given row in an entity or table and does not contain a NULL value.



COURSE -> COURSE_CODE, COURSE_NAME, AGENCY_CODE, AGENCY_NAME, COURSE_SKILL,
COURSE_END_DT, COURSE_START_DT, COURSE_DUR

Figure 4: Course

COURSE_DUR is an example of **a derived attribute,** where the value is calculated (derived) from COURSE_END_DATE – COURSE_START_DATE

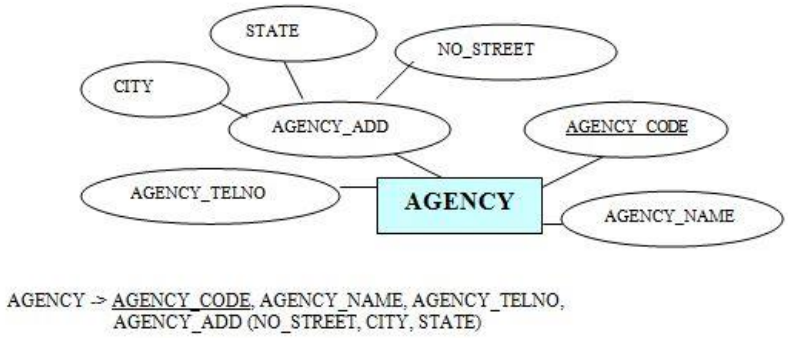


Figure 5: Agency

AGENCY_ADD is a composite attribute. Depending on the user requirements, the DD can choose to break down the address into CITY, STATE, and NO_STREET if for example, the user requires a report on the number of agency per state, or per city. In this example, we will break it down into 3 different attributes.

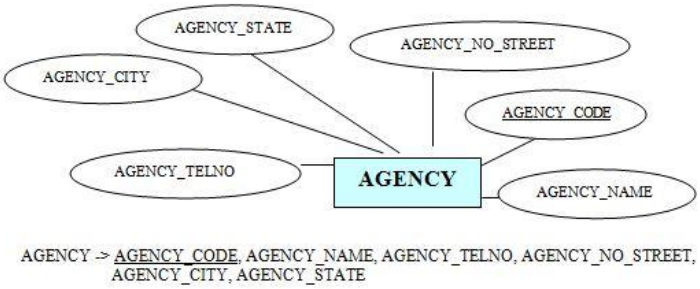
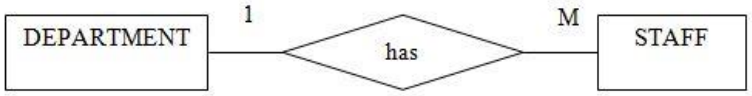


Figure 6: Agency

As stated previously, the identification of a PK or a CPK is very important to prepare for the logical design phase when the DD begins to create tables and relationships. The PK or CPK is used to uniquely identify any given row in a table and will also be used in a relationship between two tables. A foreign key (FK) of a table (Table A) is a PK (or part of a PK) of another table (Table B) that the table (Table A) relates to. This can be illustrated in the below example:

- A department has many staff and each staff belongs to only one department.



Relational Schema

STAFF (STAFF_NUM, STAFF_NAME, STAFF_DOB, DEPT_CODE)
PK: STAFF_NUM
FK: DEPT_CODE (to link to table DEPARTMENT)

Figure 7: Relationship

DEPT_CODE is a FK in table STAFF. This means table STAFF has a relationship with table DEPARTMENT and that the PK (or part of a PK) of table DEPARTMENT is DEPT_CODE. Hence, table STAFF and table DEPARTMENT are linked via DEPT_CODE.

DEPARTMENT (DEPT_CODE, DEPT_NAME)
PK: DEPT_CODE
FK: none

Table STAFF and table DEPARTMENT are linked via DEPT_CODE. Hence, there is no FK in table DEPARTMENT.

In the following section, using the same case study example, the next step in developing a conceptual model by using an ER diagram is explained.

STEP 3: DEFINE THE RELATIONSHIPS AMONG THE ENTITIES

- **One or many staff can apply for one or many courses**

Relational Schema

STAFF (STAFF_NUM, STAFF_NAME, STAFF_DOB, STAFF_SKILL, STAFF_POSITION, STAFF_GRADE
DEPT_CODE, DEPT_NAME, STAFF_TELNO, DATE_EMPLOY)

COURSE (COURSE_CODE, COURSE_NAME, AGENCY_CODE, AGENCY_NAME, COURSE_SKILL,
COURSE_END_DT, COURSE_START_DT)

Figure 8: Relationship Scheme

M:N relationship is not supported in relational database environment. However, it can be implemented by introducing a **composite entity** (or a bridge entity / associative entity) in a 1: M relationship with the original entities.

APPLICATION is a composite entity

Relational Schema for composite entity

APPLICATION (APPLICATION_REF, APPLICATION_DT, STAFF_NUM, COURSE_CODE)
PK: APPLICATION_REF
FK: STAFF_NUM (to link to table STAFF), COURSE_CODE (to link to table COURSE)

Figure 9: Relationship Scheme for Composite Entity

- **One of many courses offered by one or many agencies**

Relational Schema

AGENCY (AGENCY_CODE, AGENCY_NAME, AGENCY_TELNO, AGENCY_NO_STREET,
AGENCY_CITY, AGENCY_STATE

COURSE (COURSE_CODE, COURSE_NAME, AGENCY_CODE, AGENCY_NAME, COURSE_SKILL,
COURSE_END_DT, COURSE_START_DT)

Figure 10: Relationship Scheme for course

OFFER is a composite entity

Relational Schema for composite entity

OFFER (OFFER_REF, OFFER_DT, AGENCY_CODE, COURSE_CODE)
PK: OFFER_REF
FK: AGENCY_CODE (to link to table AGENCY), COURSE_NUM (to link to table COURSE)

Figure 11: Relationship Scheme for Offer

- **One or many staff can attend one or many courses**

Relational Schema

STAFF (STAFF_NUM, STAFF_NAME, STAFF_DOB, STAFF_SKILL, STAFF_POSITION, STAFF_GRADE
DEPT_CODE, DEPT_NAME, STAFF_TELNO, DATE_EMPLOY)

COURSE (COURSE_CODE, COURSE_NAME, AGENCY_CODE, AGENCY_NAME, COURSE_SKILL,
COURSE_END_DT, COURSE_START_DT)

Figure 12: Relationship Scheme for Staff

ATTEND is a composite entity

Relational Schema for composite entity

ATTEND (ATTEND_REF, ATTEND_DT, STAFF_NUM, COURSE_CODE)
PK: ATTEND_REF
FK: STAFF_NUM (to link to table STAFF), COURSE_CODE (to link to table COURSE)

Figure 13: Relationship Scheme for Attend

Based on all of the above information, a complete ER diagram can be developed and from the ER diagram, use the attributes which have been identified to create relational tables. The process to create an ER diagram is an iterative process. The DD can review the design and verify its accuracy with the user.

STEP 4: COMPLETE THE INITIAL ER DIAGRAM FOR HRTM

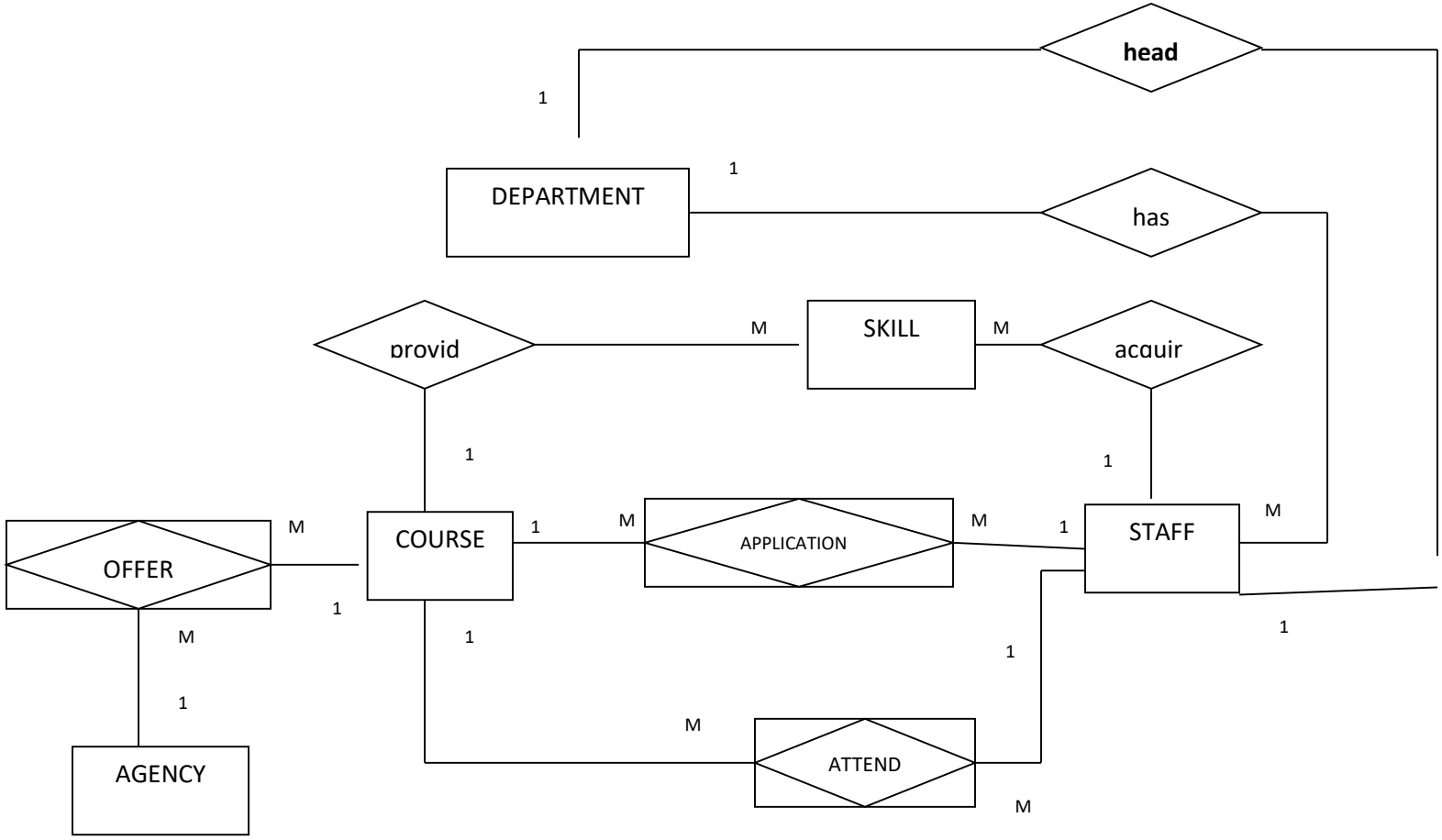


Figure 14: Diagram for HRTM

CONCLUSION

To develop a database application as a tool for data repository and data access requires a good database design. A good database design will allow fast data retrieval and improve the usage of query manipulation. The most crucial phase in database design is conceptual design phase. In the conceptual design phase, a data model is created based on the collection of data and information are gathered during the requirement specification phase. In this phase, the functional requirements according to the business and the users' needs are identified and analyzed so that the data model can support them. The DD will conceptualize the users' needs toward the system or application into a set of entities, a set of attributes for each entity, and also relationships between the entities. This is the most challenging task for the DD in database design. The approach that is commonly used to conceptualize data in database design is known as ER modeling. This approach is widely used in teaching students or beginners to design a database. In developing an ER model, getting the business rules accurately is very important. Hence, the involvement of users during user requirement study and to document and report the findings of study are very crucial. A good collection of business rules will derive a set of entities, attributes, relationships and constraints that can support all the information needed by the users through the application they use. Lastly, the ER model that is created should be validated through a series of reviews and feedback process until the entire component in the ER model is refined and accepted by the users.

REFERENCES

Bodart, F., Patel, A., Sim, M., & Weber, R. (2001). Should optional properties be used in conceptual modeling? A theory and three empirical tests. Information Systems Research, 12(4), pp.384-405.

Chen, P. (1976). The entity-relationship model -Towards a unified view of data. ACM Transactions on Database Systems, 1(1).

Codd, E. F. (1970). A relational model of data for large shared data banks. Commun ACM, 13(6):377–387.

Connolly, T., & Begg, C. (1998). Database systems: A practical approach to design implementation and management (2nd ed.). Reading, Massachusetts: Addison-Wesley.

Connolly, T. & Begg, C. (2002). Instructor's guide to database systems: A practical guide to design, implementation and management. Harlow: England.

Coronel, C. & Morris, S. (2015). Database systems: Design, implementation, and management (11th Ed.). Cengage Learning.

Hoffer, J.A., Prescott, M.B., & McFadden, F.R. (2002). Modern database management (6th ed.). Upper Saddle River, New Jersey: Prentice-Hall.

Kimball, R.A. (August, 1997). Dimensional modeling manifesto: Drawing a line between dimensional modeling and ER modeling techniques,10(9). Retrieved February 10, 2016, from http://www.dbmsmag.com/9708d15.html.

Kroenke, D.M. (2003). Database concepts. Upper Saddle River, New Jersey: Prentice-Hall.

Rob, P. & Coronel, C. (2007). Database systems: Design, implementation, and management (8th ed.). Boston: Course Technology Ptr.