Chapter 3

Information System Design

3.1 Data Modeling (2)

The information system of the project will approach to relational database concept that is widely used. The concept of relational database design is to keep all related information items together with no redundancy. The steps in relational database design can be classified into 2 major steps; that is, data modeling and building relational database.

Data modeling is a technique for clearly representing the information structures and rules called data model, an input to the step of building relational database. Building relational database is a procedure for translating the data model into an equally relational database which stores data in the form of tables.

The information of Planning and Development Division is mostly summarized information sent in from various departments and affiliations as previously explained. The sources of information are very much different in functions, so most of the information items are not related to one another. This information is already summarized and therefore it is relevant mainly to the upper management level specifically.

For the concept of relational database design, the information items should be classified into similar topic or properties. Clearly, the information currently received is not suitable for the application of this concept. However, there is only one feature of relational database which information can be stored in the form of table, can be applied with this kind of information.

In conclusion, it is likely that the design of Planning and Development Division information will not make use of the step of data modeling. The information will be mapped into tables seperately for each type of information, And obviously one cannot find clear relationship between tables.

Anyway data modeling step should be shown to complete relational database design steps; therefore, other pieces of information concerning Engineering Instructors should be collected and appropriately shown as an example model for the design steps.

The following are data modeling steps of Engineering Instructor information system.

3.1.1 Identify Major Entities

The first step in data modeling is to define the major objects in which the user is interested. These major objects are called entities. They may be real, tangible items or abstract concepts.

The task of identifying the entities can be described as follows:

- Have the user describe the business activities and collect the related documents for further study.
- Group the related information items together based on similarities in definitions and properties to form an object of interest.
- Assign names that are meaningful to each entity.

The information items of Engineering Instructor information of Chulalongkorn University are categorized as follows:

- Personal Identification (รหัสประจำตัว)
- Position Account (เลขประจำตำแหน่ง)
- Name Prefix (คำนำหน้า)
- Name - Surname (ชื่อ - นามสกุล)
- Sex (เพศ)

- Date of Birth (วัน/เดือน/ปี เกิด)
- Current Address (ที่อยู่ปัจจุบัน)
- Marital Status (สถานภาพสมรส)
- Degree (ระดับการศึกษาสูงสุด)
- Expertise (สาขาวิชาที่เชี่ยวชาญ)
- Faculty Rank (ตำแหน่งทางวิชาการ)
- Step (ระดับ)
- Salary Level (ขั้นเงินเดือน)
- Date of Employment (วัน/เดือน/ปี ที่เริ่มรับราชการในจุฬาฯ)
- Date Received the Instructor Title
  (วัน/เดือน/ปี ที่ได้ตำแหน่งอาจารย์)
- Date Received the Assistant Professor Title
  (วัน/เดือน/ปี ที่ได้ตำแหน่งผู้ช่วยศาสตราจารย์)
- Date Received the Associate Professor Title
  (วัน/เดือน/ปี ที่ได้ตำแหน่งรองศาสตราจารย์)
- Date Received the Professor Title
  (วัน/เดือน/ปี ที่ได้ตำแหน่งศาสตราจารย์)
- Year Received Special Salary Promotion
  (ปี พ.ศ. ที่ได้เลื่อนขั้นเงินเดือนกรณีพิเศษ)
- Special Rank (ตำแหน่งทางราชการที่สำคัญ)
- Organization Name (ชื่อหน่วยงาน)
- Starting Date (วัน/เดือน/ปีที่เริ่มเข้ารับตำแหน่ง)
- Stopping Date (วัน/เดือน/ปีที่สิ้นสุดการรับตำแหน่ง)
- Project Name (ชื่อโครงการ)
- Proposed Date for Project's Commencement (วัน/เดือน/ปี ที่เริ่ม)
- Proposed Date for Project's Completion (วัน/เดือน/ปี ที่สิ้นสุด)
- Actual Date of Project's Completion
  (วัน/เดือน/ปี ที่เสร็จสิ้นโครงการจริง)
- Project Abandonment Date (วัน/เดือน/ปี ที่ถูกยกเลิกโครงการ)
- Participating Ratio (สัดส่วนที่ทำ)
- Position in Project (ตำแหน่งในโครงการ)
- Financial Source (แหล่งทุน)
- Academic Contribution Description (รายละเอียด/ชื่อ)

- Type of Academic Contribution (ประเภท)
- Year of Publication (ปีที่พิมพ์)
- Number of Pages of the Academic Contribution (จำนวนหน้าที่เขียน)
- Number of Pages of the Whole Document (จำนวนหน้าทั้งเล่ม)
- Creating Ratio (สัดส่วนที่เขียน)

After consideration and grouping the items of the same properties and similarities, the entities of Engineering Instructor information can be identified as the following:

- Instructor (คณาจารย์)
- Officialdom (การรับราชการ)
- Research (งานวิจัย)
- Academic Contribution (ผลงานทางวิชาการ)

3.1.2 Determine Relationships Between Entities

A relationship is a fact about or an association between two entities. Typically a verb or a preposition connecting two entities implies a relationship. Relationships may be classified into three types.

- Existence Relationship
- Functional Relationship
- Event Relationship

A Relationship has a direction, the direction indicates which of the two entities involved in the relationship is the "from" entity (referred to as the parent) and which is the "to" entity (referred to as the child).

The relationship can be considered in another way. It can be seperately grouped into three types based on cardinality ratio as follows:

- One-to-One Relationship, which associates each entity occurrence with one occurrence of the related entity.

- One-to-Many Relationship, which associates each occurrence of the parent entity with zero, one or many occurrences of the child entity.

- Many-to-Many Relationship, which associates each occurrence of the parent entity with zero, one or many child occurrences and conversely each child occurrence with zero, one or many parent occurrences.

From previous steps, the relation between each couple of entities can be assigned as displayed in the diagram, as shown:

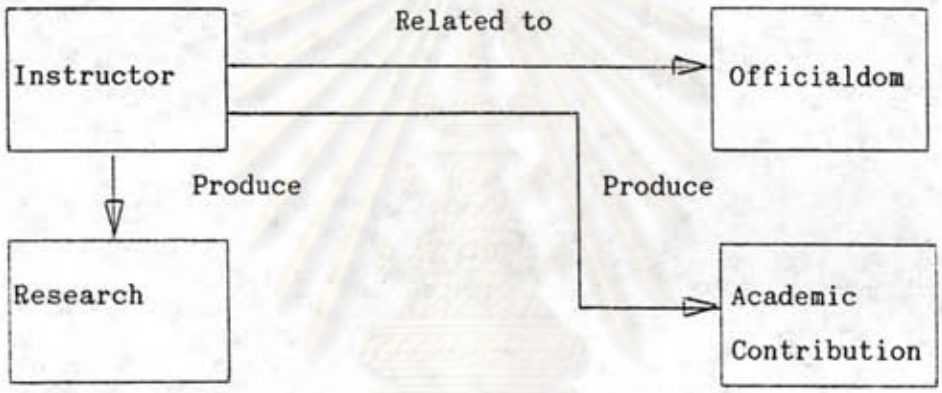

Figure 3.1 : Relationships between Couples of Engineering Instructor information entities

The Instructor entity has a relationship of "related to" to Officialdom entity and has a relation of "produce" to both Research entity and Academic Contribution entity.

3.1.3 Determine Primary and Alternate Keys

An attribute is an atomic unit of the information about an entity. It is a nondecomposible piece of information describing an entity and the first two attributes that have to be added to the data model are primary key and alternate key respectively.

The primary key and the alternate key are to be selected from candidate keys. A candidate key is an attribute or a set of attributes that uniquely identifies a specific occurrence of an entity. From this point, one of the candidate keys has to be selected to serve as a primary key which can not only uniquely identifies a specific occurrence but also exists for every occurrence of the entity.

The candidate keys that are not selected to be the primary key are called alternate keys.

Identification of primary and alternate keys is important for the following reason:

- They are unique for each occurrence.
- At least the primary key and may be some alternate keys are always present for each occurrence, and the existence of a primary key makes sure that there is a way to reference of any occurrence.

In Instructor entity, there are two attributes that can uniquely identify each instructor, that is Personal Identification and Position Account. They are both candidate keys and because Personal Identification is frequently, widely referred to; and each Personal Identification has to be assigned to each instructor, so it is selected to be the primary key and the Position Account has to be alternate key automatically.

After considering through the rest entities which are Officialdom, Research and Academic Contribution, the way of identifying each occurrence of the entity is via both Personal Identification and Position Account. So, the Personal Identification is chosen to be the primary key and Position Account has to be the alternate key.

The following is the summary list showing the primary and alternate keys of each entity.

Entity	Primary key	Alternate key
Instructor	Personal Identification	Position Account
Officialdom	Personal Identification	Position Account
Research	Personal Identification	Position Account
Academic Contribution	Personal Identification	Position Account

3.1.4 Determine Foreign Keys

A foreign key is an attribute or a set of attributes that completes a relationship between a couple of entities by identifying the parent. If the specific parent occurrence is identified, the child occurrences related to that specific parent occurrence can be viewed by identifying the foreign key value from the parent occurrence. The foreign key is placed in the entity and equates to the primary key of its parent entity.

Here is the list showing foreign keys of each child entity.

Parent-Child Entity	Foreign key of the child entity
Instructor-Officialdom	Personal Identification
Instructor-Research	Personal Identification
Instructor-Academic Contribution	Personal Identification

3.1.5 Determine Key Business Rules

Business rules are the way to define data integrity which ensures the correctness and consistency of data. Key business rules are the rules that define the integrity of relationships. These rules cover the effects of insert, delete and update operations on relationships.

The insert rule determines the valid conditions or restrictions associated with parent entity when a child entity is inserted. The rules can be classified into 6 types.

- Dependent : Child entity occurrence can be inserted only when matching parent entity occurrence already exists.

- Automatic : Child entity occurrence can be inserted, but if matching parent entity occurrence does not exist, create it.

- Nullify : Child entity occurrence can be inserted, but if matching parent entity occurrence does not exist, set the foreign key in child entity to null value.

- Default : Child entity occurrence can be inserted, but if matching parent entity occurrence does not exist, set foreign key in child entity to a pre-defined default value.

- Customized : Child entity occurrence can be inserted, if certain customized validity constraints are met.

- No effect : Child entity occurrence can be inserted, without checking in any matters.

The delete rule determines the valid conditions or restrictions associated with child entity when a parent entity is deleted, the rules can be classified into 6 types.

- Restrict : Parent entity occurrence can be deleted only when there is no matching child entity occurrence.

- Cascade : Parent entity occurrence can be deleted, and all the matching child entity occurrences have to be deleted accordingly.

- Nullify : Parent entity occurrence can be deleted, but if any matching child entity occurrence exists, set its foreign key to null value.

- Default : Parent entity occurrence can be deleted, but if any matching child entity occurrence exists, set its foreign key to default value.

- Customized : Parent entity occurrence can be deleted only if certain customized validity constraints are met.

- No effect : Parent entity occurrence can be deleted, without checking in any matters.

Considering insert rules of the three child entities, Offcialdom, Research and Academic contribution in the following couples of entities.

- Instructor - Officialdom
- Instructor - Research
- Instructor - Academic Contribution

The three child entities have the same own parent entity, Instructor. Officialdom information, Research information or Academic Contribution information of a specific instructor should not be added into each entity, if the instructor information has not yet been added into Instructor entity. After the Instructor entity is added already, each child entity can be added. So, this means that insertions of the three child entities are dependent on the insertion of their parent entity.

Considering the delete rules for the three child entities, if the Instructor entity information is to be deleted which means that there will not be such an instructor information any more, so the rest of information in each child entity should be deleted accordingly. The delete rule for the three child entity is cascade rule.

Considering the update rules for the three child entities, if each child entity information has to be changed, the other entities (even the parent) should not be effected. So the update rule is no-effect rule.

Here is the list of rules corresponding to each pair of entities:

Pairs of Entities	Insert	Delete	Update
Instructor-Officialdom	Dependent	Cascade	No effect
Instructor-Research	Dependent	Cascade	No effect
Instructor-Academic Contribution	Dependent	Cascade	No effect

3.1.6 Add Remaining Attributes

At this point each entity has its own primary and alternate keys already. The rest of attributes or information items will be associated with an appropriate entity.

The remaining attributes placed within the entity have to be dependent on the entire primary key; that is, a particular value of the primary key can determine the value of all other attributes.

The remaining attributes of each entity of Engineering Instructor information can be associated as follows:

Entity Name	Attribute Name	Type
Instructor	Personal Identification	PK
	Position Account	AK
	Name Prefix	
	Sex	
	Date of Birth	
	Current Address	
	Marital Status	
	Expertise	
	Degree	
Officialdom	Personal Identification	PK
	Position Account	AK
	Faculty Rank	
	Step	
	Salary Level	
	Date Received of Employment	
	Date Received the Instructor Title	
	Date Received the Assistant Professor Title	
	Date Received the Associate Professor Title	
	Date Received the Professor Title	
	Year Received Special Salary Promotion	
	Special Rank	

Entity Name	Attribute Name	Type
	Organization Name	
	Starting Date	
	Stopping Date	
Research	Personal Identification	PK
	Position Account	AK
	Project Name	
	Proposed Date for Project's Commencement	
	Proposed Date for Project's Completion	
	Actual Date of Project's Completion	
	Project Abandonment Date	
	Participating Ratio	
	Position in Project	
	Financial Source	
Academic	Personal Identifĭcation	PK
Contribution	Position Account	AK
	Academic Contribution Description	
	Type of Academic Contribution	
	Year of Publication	
	Number of Pages	
	Number of Pages of the Whole Document	
	Creating Ratio	

Note : For Type Field,
PK means Primary Key.
AK means Alternate Key.
Blank means Normal or Remaining Attributes.

3.1.7 Validate Normalization Rules

Normalization is the way to create an optimal data model which meets the design objectives of correctness, consistency, simplicity and nonredundancy. The normalized design would provide the following advantages:

- Minimize amount of space to store data due to the fact that it prevents storing data in multiple places.
- Minimize data inconsistency within the database due to the fact that data is stored only once and this reduces the risk of data values becoming inconsistent.
- Minimize number of deletions and updates.

Normalization includes several steps in processing. They are known as first, second, third, Boyce/Codd, fourth and fifth normal forms.

First, second and third normal forms are easiest to understand but most important. The third normal form is adequate to ensure a correct, consistent and nonredundant data model. The fourth and fifth normal forms are quite complex and in fact, data model that is in third normal form is usually in fifth normal form as well.

First normal form is the form requiring that each entity occurrence has a fixed number of single-valued attributes. An entity in first normal form does not contain repeating groups. Each attribute is atomic and has a unique meaning and name. First normal form is necessary for the following reasons:

- The result of it can be applied in further normalization steps
- The form is simple

Second normal form is the form requiring that each nonkey attribute in the first normal form be dependent on the entire primary key. It prohibits assignment of nonkey attribute to the entity where a subset of the primary key can determine the nonkey attribute.

Third normal form is the form requiring that each nonkey attribute in the second normal form depends only on the primary key and nothing but primary key.

Since the third normal form is adequate for normalization process. The rest of the normal forms will not be referred to here and further normalization will be based on first to third normal forms only.

For Instructor entity, all the attributes can be placed in the view of table, as below:

Instructor Entity

Personal Id	Position Account	Prefix	Name	Sex	Date of Birth	Curr Address
Marital Status	Degree	Expertise				

From the presentation the Expertise attribute is the only attribute that can have multi values when a specific Personal Identification is applied. Therefore, the Instructor entity is not in first normal form.

To reduce the Instructor entity into first normal form, the Expertise attribute is removed from the Instructor entity and placed to a new child entity called "Expert Field" entity and due to the fact that the child entity should have the same primary key as its parent. So, the primary key for Expert Field entity is Personal Identification. But if the new child entity has only Personal Identification as the primary key, the primary key will not be unique; so the new attribute called Sequence is added as an element of the entire primary key to ensure the uniqueness. The Instructor entity, after being reduced to first normal form, and the newly created Expert Field entity are shown as follows:

Instructor Entity

Personal Id (PK)	Position Account	Prefix	Name	Sex	Date of Birth	Curr Address
Marital Status	Degree					

Expert Field Entity

Personal Id (PK)	Sequence (PK)	Expertise

Note : PK means primary key.

For Officialdom entity, the table view can be shown as follows:

Officialdom Entity

Personal Id (PK)	Position Account	Faculty Rank	Step	Salary Level	Date of Employment
Date Received Instructor Title	Date Received Assistant Prof. Title	Date Received Associate Prof. Title	Date Received Prof. Title		
Year Received Special Salary	Special Promotion	Special Rank	Organization Name	Starting Date	Stopping Date

The entity is not in first normal form due to the fact that Year Received Special Salary Promotion attribute can have multi values. The reduction process has to be done with this attribute to create a child entity called "Salary Promotion" which has Personal Identification and Sequence attributes as entire primary key.

After first reduction, the Officialdom entity still has the multi-valued attributes; that is, Special Rank which has to be associated with Organization name, Starting date and Stopping date. The second reduction has to take place in order to acquire the new child entity, called "Special Rank" which includes two important attributes that can be used to establish the entire primary key, namely Personal Identification and Special Rank. All entities after reductions are shown as follows:

Officialdom Entity

Personal Id (PK)	Position Account	Facutly Rank	Step	Salary Level	Date of Employment

Date Received Instructor Title	Date received Assistant Prof. Title	Date Received Associate Prof. Title	Date Received Prof. Title

Salary Promotion Entity

Personal Id (PK)	Sequence (PK)	Year Received Special Salary Promotion

Special Rank Entity

Personal Id (PK)	Special Rank (PK)	Organization Name	Starting Date	Stopping Date

For Research entity, the table view can be seen as follows:

Research Entity

Personal Id (PK)	Position Account	Project Name	Proposed Date for Commencement	Proposed Date for Completion

Actual Date of Completion	Project Abandonment Date	Participating Ratio	Position in Project

Financial Source

The Research entity cannot be reduced into another entity. All attributes can only have a specific value for certain primary key. So this entity is in first normal form already.

For the Academic Contribution entity, the table view also can be shown:

Academic Contribution Entity

Personal Id (PK)	Position Account	Academic Contribution Description	Type	Year of Publication	Number of Pages

Number of Pages of the Whole Document	Creating Ratio

Each attribute has a specific value for a certain primary key value and it is in first normal form already.

3.1.8 Determine Domains

A domain is a set of valid values for an attribute. It is a pool of logical values from which one or more attributes draw their values.

There are two ways to define the domain of attributes; one is to define domains up front and associate each attribute in data model with the appropriate domain, the other is to assign domain characteristics to each attribute.

Domains are important for the following reasons:

- To verify data value.
- To ascertain whether two occurrences of the same value in two different attributes represent different meanings.

The typical types of domain characteristics are as follows:

- Data type
- Data length
- Format

- Allowable value constraints
- Meaning
- Uniqueness
- Null support
- Default value

There are rules for defining domains of each attribute type described below:

- Primary key is unique.
- Primary key cannot be null.
- Primary key may accept default value.
- Alternate key is unique.
- Alternate key may be null.
- Alternate key may accept default value.
- Data type, length and format of the foreign key must be the same as those of the corresponding primary key in the parent entity.
- Uniqueness property of foreign key must be dependent on relationship type (that is only one-to-one relationship implies unique foreign key).
- Null support, default values and allowable value constraints for foreign keys must follow key business rules of its parent primary key.

Other Attributes Domain Rules

- Domains for all other attributes in data model should follow rules defined by user.

3.2 Building a Relational Database

3.2.1 Identify Tables

An entity is a logical object in which information is placed. In a relational environment, a table is a collection of rows, where each row has the same columns.

The starting step of building relational database is to translate each entity into a relational table. Formally one entity is mapped into one table, not to segment one entity into multiple tables, nor to combine several entities into one table.

3.2.2 Identify Columns

A row of table is as a record of related data items. The related data items are called columns. The attributes of an entity in the data model are assigned based on their business definitions and associated dependencies, so the attributes in an entity are represented as columns in the corresponding table.

3.3.3 Adapt Data Structure and Key Business Rules to Product Environment

Sequencing Columns in Table

Generally the ordering of column names in command to create table of each Relational Data Base Managment System (RDBMS) establishes the real sequence of columns in storage. In fact, any sequence retrieve columns in any order.

However, there may be specific rules in some DBMS's, for example it may require variable-length column to be the rightmost column. But for ORACLE RDBMS which is used to implement the thesis the column names can be in any sequence. So, the instructor information tables do the defining of the sequence of columns as in the data model.

Enforcing the Primary Key Properties

A primary key should have the properties of uniqueness, and cannot contain null values. This can be defined by either of the 2 ways:

- By RDBMS Data Definition Language (DDL)

In some RDBMS's, there is not such clause provided and ORACLE RDBMS is the case. There is no direct means of specifying which attribute(s) participate in the primary key, so the NOT NULL clause which is the normal domain definition to be affixed to the primary key attribute and this can enforce only the not null property.

Enforcing Domains Characteristics of the Attributes

By DDL, domains characteristics can be defined as parts of command to create table. Using ORACLE RDBMS, enforcing domains characteristics can be done in the following items:

- Data types : There are 4 different data types in ORACLE RDBMS; CHAR LONG DATE and NUMBER. CHAR and LONG, identify the data values as being character strings. For CHAR the longest is 240 characters but LONG can be contained up to 65,536 characters. The DATE, identifies the data values in the format of dd-mmm-yy (dd : represents the day of the month, mmm : represents the first 3 characters of the month and yy : represents the last 2 digits of the year). The last data type is NUMBER which can store both integer and real numbers.
- Length : can be specified after data types
- Format : to be implied with the data types
- Uniqueness : can be specified by NOT NULL clause
- Null support
- Allowable value constraints and default values can be implemented in further part

Enforcing Key Business Rules or Relationship Business Rules

Key business rules are used to control the 3 operations (insert, delete and update) on the primary key and foreign key which effect the related entities or tables.

There are 2 ways of doing so:

- By RDBMS DDL

This presumes DDL can support for defining the primary key and foreign key clauses. The rules can be specified as parameters in the foreign key clause.

- By triggering operation implementation technique

Since many RDBMS's including ORACLE do not support such DDL, key business rules have to be implemented by triggering operation technique which will be described in defails later.

As the result from the step of Building a Relational Database, the definitions of table structure of Engineering Instructor information are summarized in the Appendix B of this thesis.

For the Planning and Development Division information the steps of relational database design are discarded. Only the concept of storing data in the form of tables is to be used. The steps of building such information system are described as follows:

- Defining the topics of interest
- Defining the information items within the topic
- Map the topics of interest into table names
- Map the information items into column names

The outcomes of applying the mentioned steps with Planning and Development Division information are summarized after this.

The following is the list of information items of the topics of interest and their corresponding column names of the newly defined tables.

Topic of interest	Table name
Number of personnel	PERSONNEL

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Number of type-A personnel	NUM_OF_TYPEA
Number of type-B personnel	NUM_OF_TYPEB
Number of type-C personnel	NUM_OF_TYPEC

Topic of interest	Table nsme
Number of instructors	INSTRUCTOR

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Number of professors	NUM_OF_PROF
Number of associate professors	NUM_OF_ASSO_PROF
Number of assistant professors	NUM_OF_ASST_PROF
Number of lecturers	NUM_OF_LECTURER
Number of doctorate's degree holders	NUM_OF_DOCTORATE
Number of master's degree holders	NUM_OF_MASTER
Number of bachelor's degree holders	NUM_OF_BACHELOR
Number of instructors whose ages are not over 30	NUM_OF_AGE_NOT_OVER_30
Number of instructors whose ages are between 31 and 40	NUM_OF_AGE_BET_31_40
Number of instructors whose ages are between 41 and 50	NUM_OF_AGE_BET_41_50
Number of instructors whose ages are between 51 and 60	NUM_OF_AGE_BET_51_60

Topic of interest	Table name
Number of students	STUDENT

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Number of 1st-year undergraduates	NUM_OF_1ST_YR_BACHELOR
Number of 2nd-year undergraduates	NUM_OF_2ND_YR_BACHELOR
Number of 3rd-year undergraduates	NUM_OF_3RD_YR_BACHELOR
Number of 4th-year undergraduates	NUM_OF_4TH_YR_BACHELOR
Number of student trainees	NUM_OF_TRAINEE
Number of master's degree students	NUM_OF_MASTER
Number of post-graduates of higher certificate	NUM_OF_HIGH_CERT
Number of doctorate's degree post-groduates	NUM_OF_DOCTORATE

Topic of interest	Table name
Number of graduates	GRADUATE

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Number of 1st-class honour graduates	NUM_OF_1ST_HONOUR
Number of 2nd-class honour graduates	NUM_OF_2ND_HONOUR
Number of ordinary graduates	NUM_OF_NML_GRAD

Topic of interest	Table name
Government budget	GOVMNT_BUDGET

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Salary	G_SALARY
Wages	G_WAGES
Temporary wages	G_TEMP_WAGES
Remuneration	G_REMUNERATION
Supplies	G_SUPPLIES
Equipment	G_EQUIPMENT
Property and construction	G_PROP_AND_CONST
Subsidies	G_SUBSIDIES
Compensating equipment	G_COMP_EQUIPMENT

Topic of interest	Table name
Departmental budget	DEPT_BUDGET

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Salary	D_SALARY
Wages	D_WAGES
Temporary wages	D_TEMP_WAGES
Remuneration	D_REMUNERATION
Supplies	D_SUPPLIES
Equipment	D_EQUIPMENT
Property and construction	D_PROP_AND_CONST
Subsidies	D_SUBSIDIES
Compensating equipment	D_COMP_EQUIPMENT

Topic of interest	Table name
Graduate School budget	POST_GRAD_BUD

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Amount of 60-percent budget	BUDGET_60
Amount of 40-percent budget	BUDGET_40
Amount of budget after deduction	BUD_FR_DEDUC

Topic of interest	Table name
Library statistics	LIB_STAT

Information item	Column name
Year	YEAR (PK)
Month	MONTH (PK)
Number of users	NUM_OF_USER
Number of borrowed books	NUM_OF_BORROWED_BOOK

Topic of interest	Table name
Library members	LIB_MEMBER

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Number of members who are undergraduates	NUM_OF_BACHELOR_MEM
Number of members who are post-graduates in master's degree programmes	NUM_OF_MASTER_MEM
Number of members who are post-groduates in doctorate's degree programmes	NUM_OF_DOCTORATE_MEM

Number of members who are faculty members	NUM_OF_LECTURER_MEM
Number of members who are alumni	NUM_OF_ALUMNI_MEM
Number of members who are government officials	NUM_OF_GOVMNT_OFF_MEM

Topic of interest	Table name
Text and Instructional materials	INST_DOCUMENT

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Topic	TOPIC (PK)
Type	TYPE
Writer	WRITER
Publisher's name	PUBLISHER_NAME
Year of publication	PUBLISHED_YEAR
Number of pages	NUM_OF_PAGE

Topic of interest	Table name
Scholarship	SCHOLARSHIP

Information item	Column name
Year	YEAR (PK)
Type of scholarship	TYPE (PK)
Name	NAME (PK)
Quantity	QUANTITY
Student name	STUDENT_NAME

Topic of interest	Table name
Service	SERVICE

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Description	DESCR (PK)
Authorities	PERSON_OF_AUTH
Frequency	FREQUENCY
Income	INCOME
Number of requesters	NUM_OF_REQUESTER
Kind of requesters	KIND_OF_REQUESTER
Note	NOTE

Topic of interest	Table name
Continuing education	CONT_ED

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Topic	TOPIC (PK)
Type of presentation	TYPE
Authorities	PERSON_OF_AUTH
Kind of participants	KIND_OF_PARTICIPANT
Number of participants	NUM_OF_PARTICIPANT
Date of presentation	DATE_OF_PRESENT
Venue	PLACE
Fees	FEE

Topic of interest	Table name
Research outcome	RES_OUTCOME

Information item	Column name
Year	YEAR (PK)
Department name	DEPT_NAME (PK)
Topic	TOPIC (PK)
Research leader	RESEARCHER
Support budget	SUPPORT_BUDGET
Financial source	FINANCE_SOURCE
Progress (Percent)	PERCENT_OF_PROGRESS

Topic of interest	Table name
Research unit	RES_UNIT

Information item	Column name
Year	YEAR (PK)
Unit name	UNIT_NAME (PK)
Leader's name	LEADER_NAME (PK)
Support budget for research development	SUPPORT_DEV_BUDGET
Support budget for a particular research development	SPECIFIC_DEV_BUDGET

As a result from the mapping step, the definitions of table structure of Planning and Development Division information are summarized in the Appendix B of this thesis.