

E-Business Application Development With Java Technology And Oracle: The Fortune Invest Inc. Case

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ABSTRACT

Due to the popularity of E-business applications, Web-based database application development has become an important topic in the information systems curriculum. There is a need to explore ways to teach such a topic effectively. This paper presents a teaching case on the development of an e-business application for Fortune Invest Inc. using Java server technology with Java Database Connectivity to Oracle databases. The teaching case has the following features: 1) complete coverage of the fundamentals of e-business application development. 2) systematic integration of the knowledge in database design, implementation, programming languages, networking, Web development and system analysis. 3) script execution independent of any platforms. 4) accessible web sites on the Internet with sample code provided. The teaching case was tested in upper division CIS courses in three academic quarters during the past two years at California State University, Los Angeles. The teaching approach emphasizes learning by doing in order to motivate the student and to produce an effective learning outcome. The paper is accompanied by comprehensive teaching notes as well as executable programming scripts.

Keywords: IS Curriculum, IS Education, Web Development, Database applications, E-business, Java language

1. INTRODUCTION

The proliferation of database-based e-business applications has had a profound impact on the way business is conducted. These applications provide a mechanism for delivering large volumes of information at low cost and are not affected by distance. More and more e-business application programming is based on databases rather than traditional data files. Changing business processes often require modification of these applications. Therefore, it is essential that an IS curriculum prepare graduates to function in today's e-business environments where the integration of computing and communication technologies is reshaping organizations and their fundamental processes. Unfortunately, very few teaching cases with teaching notes for complete development of an e-business application have been reported, though some teaching methodology for e-business applications (Westfall, 2001) has been published in the IS curriculum literature.

This paper attempts to fill that gap by presenting a teaching case with teaching notes for step-by-step development of an online investment portfolio company named Fortune Invest Inc., using JavaServer Page (JSP)/Java Servlet technology with Java Database Connectivity (JDBC) to Oracle. So far neither textbooks nor instructor manuals have achieved both purposes. Current textbooks cover

topics in either database systems or concepts of e-business application development, but very few books cover both topics. Furthermore, it is even harder to find any teaching case to demonstrate the development process of an e-business application starting from database design to e-business application deployment (see Section 4 for proposed project development solution).

E-business database applications are vital to any company's information systems. To remain competitive, a business has to deploy web-based database applications to provide services via the Internet and an Intranet. There are two major trends for developing e-business applications in the e-business industry. One uses JSP/Java Servlet with a JDBC driver in Database Management Systems (DBMSs) such as Oracle or IBM DB2 on the Unix, Linux and Windows platforms. The other is using the Microsoft products such as .net platform or Visual BASIC with an Open Database Connectivity (ODBC) driver connected to SQL Server. Today, JSP/Java Servlets and JDBC are a popular choice for building interactive database based e-business applications to replace traditional Common Gateway Interface (CGI) programs. It has been widely accepted because of business scalability and implementation on multiple platforms. Third-party servlet containers are available for both Apache Web Server and Microsoft Internet Information Server (IIS).

JSP/Java Servlet is Java server technology newly developed in Java 2 Platform, Enterprise Edition (J2EE) for Web services utilized in e-business application development. JSP technology allows Web developers and designers to rapidly develop and easily maintain information-rich, dynamic web pages that leverage existing business systems. Java Servlet technology provides Web developers with a simple, consistent mechanism for extending the functionality of a Web server and for accessing existing business systems. JSP technology is an extension of the servlet technology to support authoring of HTML and XML pages. When the client requests the JSP page by means of a URL containing the .jsp file name via HTTP, the JSP engine calls, compiles and executes a servlet embedded in the .jsp file for the result. This servlet (JSP instance) will then process the HTTP request, generate an HTTP response, and return the response to the client via HTML. Servlets have access to the entire family of Java Application Programming Interfaces (APIs), including the JDBC API to access any vendor's enterprise databases. JDBC is one of the most prominent and mature approaches for accessing relational DBMSs. JDBC contains Java classes and interfaces that provide low-level access to databases. The value of the JDBC API is that an application can access any source and run on any platform with API. As part of the Java family, JSP, Servlet and JDBC technology enable rapid development of web-based applications that are server and platform independent. They provide a component-based, platform-independent method for building e-business applications on the Internet.

The focus of the teaching case is to develop Fortune Invest Inc. as an e-business application using JSP/Java Servlets and JDBC in a client-server Web service environment. The goal is to teach the IS student the fundamentals of e-business database application programming with cutting-edge computing technology. This paper intends to serve as a useful teaching resource for those who are currently teaching development of e-business applications or those who are planning to teach such a course in the IS curriculum in the future.

2. BACKGROUND

A course in electronic business has become an integral part of the Information Systems curriculum in recent years. The IS 2002 Model Curriculum and Guidelines (Gorgone *et al.*, 2002) require that all IS major and minor students take an electronic business course. The Guidelines indicate that the course should provide the students with an introduction to the technical architecture and the detailed technology solutions that are required to implement reliable and efficient e-business solutions while providing a good understanding of e-business models, strategies, security and social and legal issues. The teaching case presented here fulfills the requirements listed above and includes infrastructure, development methods and database technologies specific to the e-business environment, web interface development, and e-business solution

deployment. The paper is written to achieve the above teaching goal from a technological approach.

There are various approaches to teaching an e-business application development course in colleges and universities. Most instructors discuss the theory, design and implementation concepts in the traditional format of class-lectures of the e-business application and leave it to the students to apply the theoretical concepts when employed. The advantage of this approach is that there is easily enough time to present the major concepts of e-business application development. The main disadvantage of these approaches is that teaching an e-business course without an actual implementation is like teaching a piano course by lecture only. The new approach is to create environments in which students' cognitive structures can emerge and change and provide them an opportunity to develop an e-business project with hands-on experience.

Bloom's Taxonomy (1956) indicates that there are six basic levels of cognitive skills: knowledge, comprehension, application, analysis, synthesis, and evaluation. Teaching e-business applications to CIS senior students primarily requires them to utilize the higher-order skills in this hierarchy. Instruction must be concerned with the experiences and contexts that make the student willing and able to learn. The student's role in the learning experience must be an active and self-discovering one. Students learn by fitting new information with what they already know. Developing this online Fortune Invest Inc. project provides an opportunity for students to integrate their previously acquired knowledge in database design, system analysis, networking, programming languages, Web development and project management. The teaching case emphasizes learning by doing which motivates the student to learn and produces more effective learning outcomes than passive approaches such as the traditional lecture. The goal is to provide learning experiences that give the student practice with particular operations.

The Fortune Invest Inc. case has been tested in upper division CIS courses for four classes in the previous three quarters at California State University, Los Angeles. Student response to this teaching case has been very positive and most have rated the class among the most valuable courses they have taken. Although sometimes the students complain that there is too much work involved, they have consistently appreciated the application of the theory that they learn in the classroom (i.e., taking an entire system through design, implementation, operation, and documentation).

3. METHODOLOGY

The author developed the Fortune Invest Inc. case study based on the Investment Portfolio database scenario (Dietrich, 2001) for the following reasons:

Background fit: Most CIS upper division class students in California State University, LA have some business or finance background. The topic will make use of their existing knowledge, raise their interest and prepare them for their future career.

Real-world problem solving: The terminology and data utilized in the case project reflect a real business world scenario. Students are able to do research, conduct interviews, collect data for the database and design the application interface from various resources.

Simplicity: The project is the appropriate size for an e-business application to be developed in the academic environment

Potential to be a real-time e-business application: The case project has the potential to be developed into a real-time e-business application by integration with real-time databases.

3.1. Fortune Invest Inc. Scenario

The Fortune Invest Inc. e-business application keeps track of client information and client portfolios for the company. A client may invest in stocks or mutual funds. The characteristics of a client include a unique taxpayer identification number, a name, and an address. A client can invest in many stocks and in many mutual funds.

A stock is uniquely identified by its ticker, which is the symbol on the stock exchange. The name of issue for a stock is the name of the company. A stock has a rating, which is an assessment of the stock. The principal business of a stock denotes the primary business from which the company obtains its revenue. There are several prices associated with a stock. Besides the current price of a stock, the high and low price ranges are recorded for the calendar year. The return value for a stock, which is the price appreciation, is recorded for the prior year and a five-year period.

A mutual fund is also uniquely identified by a ticker symbol and has a fund name. The principal objective of the fund is also recorded (e.g. 'G' for growth, 'I' for income, and 'S' for stability). Similar to stocks, mutual funds record a current offering price and a high and low price range. A percent yield from investment income is also maintained.

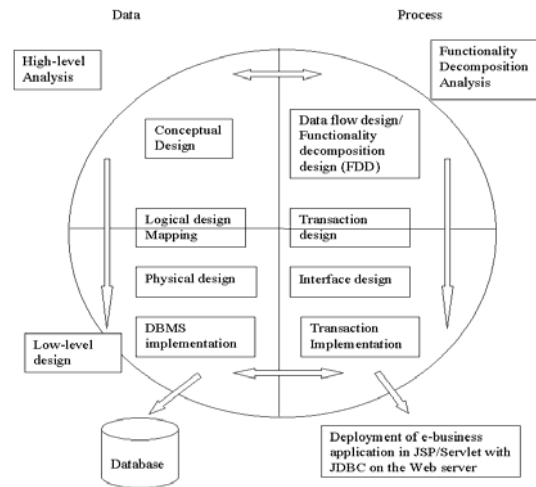
A fund family has a unique identification number and the company's name and address. A fund family, as its name implies, can have many associated mutual funds, but must have at least one mutual fund.

3.2 Case Project Development

Given the above Fortune Invest Inc. scenario, students are expected to be able to develop a complete database driven e-business application by following a systematic process from high-level data analysis through functional

decomposition and low-level database implementation to Internet deployment (see Figure 1).

Figure 1
Database Driven E-Business Development Process Diagram (Wang & Chan, 2002)



3.3 System Architecture Design

An important feature of the teaching case is the simplicity of system requirements. The JSP/Servlet code attached to the teaching case has been tested to run on a two-tier or three-tier client-server architectures such as those available with Oracle 8i and 9i.

4. TEACHING SUGGESTIONS

The teaching case is intended for senior/first-year graduate students majoring in CIS and demonstrates that it is possible for one instructor to teach a project-intensive course in which students engage in all phases of typical e-business database application development. The prerequisites for using the teaching case are that students need to have knowledge of both object-oriented programming languages and database development. However, it is also recommended that students have a networking, Web development and system analysis background.

4.1 Teaching Goal and Objectives

The purpose of this case is to introduce database Web application development technology as well as provide real world experience in e-business database application development. With these goals in mind, the author feels that the student should be able to reach the following learning objectives after successful completion of this teaching case. The students should be able to:

- Understand the development methods and database technologies specific to the e-business environment, web interface development, and e-business application deployment.

Figure 2
Client-server Architecture Connectivity Diagram
 (Connolly et al., 2002)

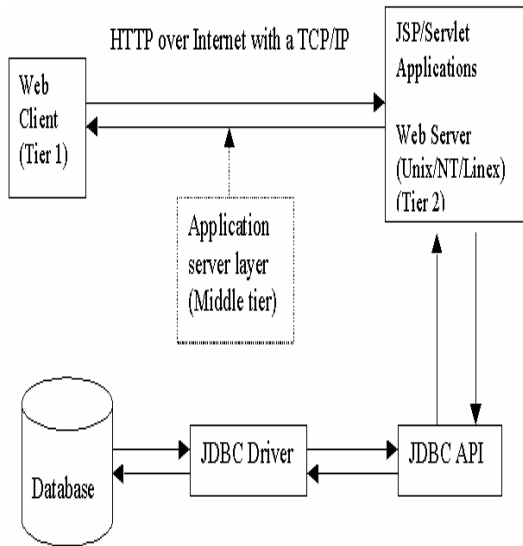


Figure 2. Client-server Architecture Connectivity Diagram (Connolly et al., 2002)

- Develop an e-business application including a complete database design and JSP/Servlet applications with embedded SQL and PL/SQL using JDBC connectivity to Oracle.

4.2 Applied Course

The content of this case is related to the following courses of the IS2002 curriculum (Gorgone *et al.*, 2002).

IS2002.2 Electronic Business Strategy, Architecture and Design

IS2002.8 Physical Design and Implementation with DBMS

IS2002.9 Physical Design and Implementation in Emerging Environments

IS2002.10 Project Management and Practice

The case appears to fit well as part of the IS2002.9 Physical Design and Implementation in Emerging Environments. The case includes aspects of electronic business strategy, architecture, and design; DBMS logical and physical design; and project management techniques. As such it provides an ideal integrative capstone experience for IS students completing an IS curriculum.

For a semester course, the case project can be utilized in the second part of a database system course. Some project courses allow students to choose their own topic for project development. If that is the case, the fortune Invest Inc.

project can be used as a sample project for demonstration of the e-business development process.

The time required to teach the case depends on the background of the students taking the course and the length of the institution academic term. The author taught the case in six out of ten weeks of an academic quarter. In order to bring all the students to the same level, the author spent the first three weeks reviewing database knowledge, and introducing Oracle DBMS and Web development. The remaining six weeks were utilized for the Fortune Invest Inc. case project development.

4.3 Project management

This case project can be utilized for either an individualized project or a team project depending on the strength of the student backgrounds. The author implemented the teaching case as an individualized project for one quarter and as a team project for two quarters. Each approach has its advantages and disadvantages. With the individualized approach, students learn more developmental skills because they have to do every part of the project by themselves. However, they miss the collaborative learning environment and teamwork experience. With the teamwork approach, it is hard to give every student the experience of implementing every part of the project, but it is instructive for students to have a collaborative learning environment and teamwork experience. Some students don't like a teamwork project because they have full-time or part-time jobs and a long commute to the campus. Thus, it is hard for them to meet other classmates outside of the classroom.

5. PROPOSED SOLUTIONS

Due to its length, the Fortune Invest Inc. project is divided into two parts (see Appendix I). Part I is designing, creating, and implementing the database with ten queries. Based on the given Fortune Invest Inc. scenario, a relational database is created in Oracle with six tables each of which is normalized to third normal form. The tables are populated with real testing data and constraints are added to the database. A function decomposition diagram (FDD) is designed to show how the database implements the business functions. Part II continues the development of the database project into an e-business application with a user-friendly graphical user interface. Based on the FDD, an e-business application user interface is designed over the web and the database application is written using embedded SQL/PLSQL programs with function modules. The web interface links to the database with JDBC, which allows the implementation of JSP/Servlet application logic with Java bean components for developing a dynamic Web Site.

PART I – DATABASE DESIGN AND IMPLEMENTATION

1) EXTRACT ENTITY TYPES

Based on the given Investment Portfolio Scenario in Section 3.1, four external entity types are extracted. They are identified as: Client, Stock, Mutual Fund and Family Fund.

2) Identify Relationship Matrix

Among the four entity types, three pairs of relationships have been identified in the following relationship matrix.

Table 1.
Relationship Matrix Of The Fortune Invest Inc.

	Client	Stock	Mutual fund	Fund family
Client	----	the investor of	the investor of	----
Stocks	Is invested by	----	----	----
Mutual funds	Is invested by	----	----	Is associated with
Funds family	----	----	Consists of	----

3) Generate Business rules

The three pairs of relationships are further defined as the database business rules as follows:

One client may invest in one or more than one stock.

A stock may be bought by one or more than one client.

One client may invest in one or more than one mutual fund.

A mutual fund may be bought by one or more than one client.

One fund family must have one or more than one mutual fund.

One fund may belong to one or more than one fund family.

4) Database Functions

The Fortune Invest Inc. database operations are illustrated in the following function decomposition diagram (FDD) top-down design chart (see Figure 3).

5) Entity-Relationship Diagram (ERD)

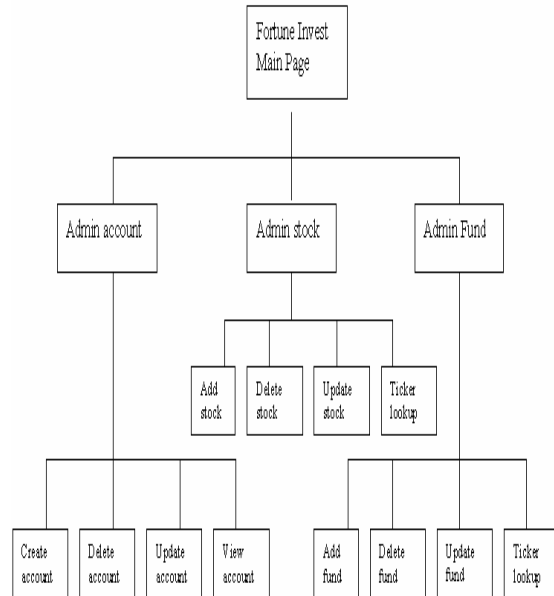
Based on the above identified external entities and relationships, the Fortune Invest Inc. entity-relationship diagram is developed using the Chen's ERD standard (see Figure4).

6) Mapping from ER Diagram to Relational Database Schemas

Six relational schemas/tables are mapped from the above ER diagram. Each table has a table name, a primary key in boldface and its corresponding additional fields.

Client (**taxId**, cName, cAddress)

Figure 3
A Function Decomposition Diagram (FDD) Top-Down design Chart



Stock (**stockTicker**, sName, ratings, prinBusiness, oneYrReturn, five YrReturn, sCurrentPrice, sAnnualHigh, SannualLow)

Mutual_Fund (**fundTicker**, fName, PrinObjective, fCurrentPrice, fAnnualHigh, fAnnualLow, Yield, fFamilyId)

Fund_Family (**fFamilyId**, fmName, fmAddress)

Stock_Portfolio (**taxId**, **stockTicker**, sNumberShares)

Fund_Portfolio (**taxId**, **FK**, **fundTicker**, fNumberShares)

7) Establish Referential integrity

The following six referential integrities are established in order to relate the six tables to each other in the database. Each of the referential integrities shows that a foreign key refers to the corresponding primary key

Stock_Portfolio.taxId (FK)→ Client.taxId (PK)

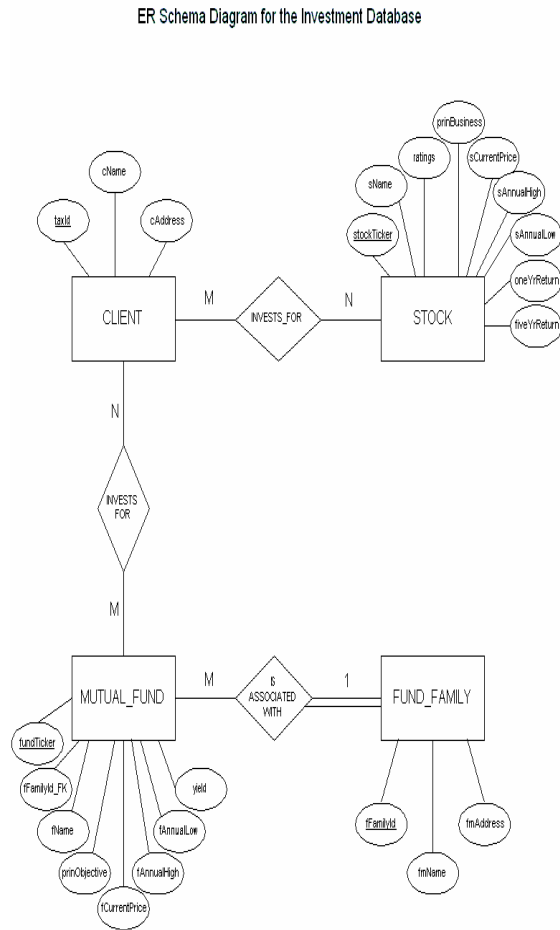
Stock_Portfolio.stockTicker (FK) → Stock.stockTicker (PK)

Fund_Portfolio.taxId (FK)→ Client.taxId (PK)

Fund_Portfolio.fundTicker (FK)→ Mutual_Fund.fundTicker (PK)

Mutual_Fund.fFamilyId (FK)→ Fund_Family.fFamilyId (PK)

Figure 4
Fortune Invest Inc. Entity-Relationship Diagram



8) Normalization

All six tables in the Fortune Invest Inc. are normalized to the third normal form. Neither partial dependencies nor transitive dependencies are presented in any of the six tables.

Functional Dependence: The functional dependency diagram is utilized as a tool to conduct the normalization.

TaxId → cName, cAddress

StockTicker → sName, ratings, prinBusiness, sCurrentPrice, oneYrReturn, fiveYrReturn, sAnnualHigh, sAnnualLow

FundTicker → fName, prinObjective, fCurrentPrice, fAnnualHigh, fAnnualLow, yield, fFamilyId

FFamilyId → fmName, fmAddress

TaxId, StockTicker → sNumberShares

TaxId, FundTicker → fNumberShares

9) Create database with constraints and show their outputs

The Fortune Invest Inc. database is created with an Oracle database engine based on the previously defined six relational schemas and referential integrity constraints. See the database creation script in the teaching notes.

10) Implement the database with 10 query questions, SQL solutions and output.

To make sure the Fortune Invest Inc. database on Oracle works correctly, ten queries are developed for the implementation of the database. They are listed as follows. The keys to these queries can be found in the teaching note.

- 1. Which clients have invested in 'B' rated stocks?
- 2. Update table client and change the client name from "Rose" to "Kim".
- 3. Create a new table mutual_fund_GE and populate it with mutual funds belonging to the fund family named GE.
- 4. Insert a row in the mutual_fund_GE table;
- 5. Delete a row from the mutual_fund_GE table whose principal objective is "Income"
- 6. Create a view for the stock Cisco
- 7. Which mutual funds are included in the 'Janus' fund family
- 8. Display those clients' taxid who have invested in at least two stocks.
- 9. Display the mutual fund name that is associated with the fund family name "GE".
- 10. Which clients have invested in more than 300 shares of "Wal-Mart Stores" stocks?

PART II – E-BUSINESS APPLICATION PROGRAMMING

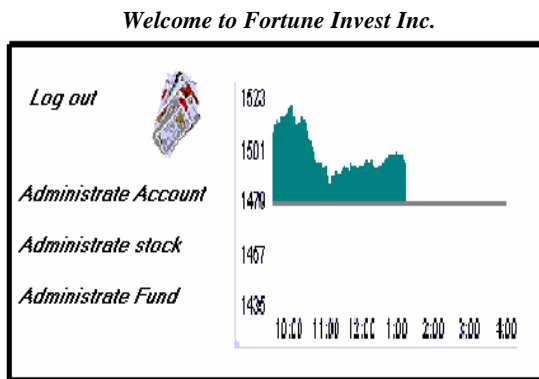
11) Display the Interface of the Fortune Invest Inc. e-Business Applications

The website interface with all the JSP/Servlets scripts is shown as follows:

12) Specify the functions to be implemented in the application.

Login – index.html

Figure 5
Main Page of Fortune Invest Inc.



Administrate Account

- Open account** – AddAccount.jsp
- Modify account** – UpdateClient.jsp
- Close account** – DeleteClient.jsp
- View account** – ViewData.jsp

Administrate Stock Portfolio

- Add Stock** – InsertStock.jsp
- Delete Stock** – DeleteStock.jsp
- Update Stock** – UpdateStoc.jsp
- Stock Ticker Lookup** – Viewdata.jsp
- View Stock Investment** – ViewStockInvestment.jsp

Administrate Mutual Fund Portfolio

- Add Mutual Fund** – InsertFund.jsp
- Delete Mutual Fund** – DeleteFund.jsp
- Update Mutual Fund** – UpdateFund.jsp
- Mutual Fund Ticker Lookup** – GetPrice.jsp
- View Fund Investment** -ViewFundInvestment.jsp

From the Fortune Invest Inc. main page (index.html), users are able to access the above files to implement the functions of the Fortune Invest Inc. application at different levels.

13) Using embedded SQL write a database application with (Insertion, deletion, update, selection, PL/SQL function and procedure, and view creation).

The above listed JSP/Servlet .jsp files have been developed for implementation of the online Fortune Invest Inc. application. They are available for download from the JISE website upon the subscribers' requests.

14) Write a comprehensive report

The report is a comprehensive summary and documentation for the project and must include the following elements:

- Project purpose
- Project users
- Project Description

15) Write a user manual for your project

The manual is a guide for end users to utilize the project and must include the following elements.

- Project URL
- Frequently asked questions
- Help Menu

6. CONCLUSION

The case provides students with a real-world, online and hands-on experience in database Web application development. Students are exposed to the challenges of working in teams to develop a database to address the information needs of a small business enterprise. Within very broad limits, students are responsible for defining a problem, designing a solution to that problem, and implementing and documenting their solution at the end of the semester. This paper provides a few suggestions to those who are or will be teaching a Database Web application development course. With this in mind, the author has attached all the executable SQL, PL/SQL and JSP/Servlet script to the article for potential instructors.

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and international conference proceedings. Her current research interests are in e-commerce globalization, e-service quality, e-satisfaction, agent technology, database Web applications, and Java server technology.

APPENDIX I

E-Business Application Project Requirements: Fortune Invest Inc.

PART I –Database Design And Implementation

1. Specify the requirements of the database by establishing a set of business rules and functions of your database.
2. Identify entity types and attributes and the relationships between entity types.
3. Generate Business Rules
4. Specify database functions
5. Draw an ER diagram for conceptual design.
6. Draw a relational schema to transform the ER Diagram to a relation database.
7. Set up referential integrity for all the join paths existing in the relational database schema from the transformation.
8. Normalize the relations in the database to 3NF using functional dependency diagram analysis.
9. Create the database with five constraints in appropriate tables and load data into the database.
10. Implement the relational database via ORACLE SQL*PLUS, which includes 10 query questions, SQL solutions and output and save them in a query script file. Your SQL statements must include insert, delete, update, view and a variety of select statements.

Part II – E-business Application Programming

11. Specify the interface of your application program with screen shots.
12. Specify the functions/operations you are going to implement in your e-business applications.
13. Using embedded SQL write a database application with (Insertion, deletion, update, selection, PL/SQL function and procedure, and view creation).
14. Write a comprehensive report as documentation for the database design, implementation.
15. Write a user manual for your project.



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