

Development of Energy Consumption Database Management System of Existing Large Public Buildings¹

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Abstract: The statistic data of energy consumption are the base of analyzing energy consumption. The scientific management method of energy consumption data and the development of database management system plays an important role in building energy conservation. At present, the large public buildings have been the emphasis of building energy conservation in China. The functions and the basic construction of energy consumption database management system (ECDBMS) for large public buildings are introduced. The ECDBMS is developed by using SQL Server 2000 as the database and PowerBuilder10.0 as the developing tool. It includes five parts such as the basic information of public buildings, the designing parameters of energy-consuming equipments, the operational parameters of energy-consuming equipments, the electric and fuel consumption of buildings, the evaluation of energy efficiency for equipments. The energy consumption database can be accumulated and some functions can be realized by using this database such as the management of building designing parameters and energy consumption data, the evaluation and analysis of building energy consumption.

Key words: existing large public buildings, designing parameters, database, energy consumption evaluation

1. PREFACE

Large public buildings are the emphasis of energy conservation currently in China. The energy consumption statistic data are the basis of analyzing and studying building energy consumption. It's more quickly to find out the problems that appeared during the operation process by energy consumption

measurement and diagnosis of energy efficiency for large public buildings, and proper measurement can be adopted to improve the system's working condition and increase the energy usage efficiency. In recent years, many institutions have carried on a series of measurement for energy consumption in China^[1-6]. Building energy consumption measurement is the important part of building commissioning in other countries also. A great deal of designing and measured data can be obtained in the process of measurement. So, it's necessary to develop a database management system aiming at operational energy consumption for buildings, in order to take a more convenient measurement and effective management for measured and statistic data, so as to be familiar with the real operational condition of air-conditioning and heating systems for researchers and building owners.

There are very few database for building's operational energy consumption, and the objects are always groups of building, not single building. Thus, it's difficult to know clearly the particular operation of energy-consuming systems of buildings^[7, 8].

2. GENERAL DESIGNING PLAN SCHEME ABOUT THE DATABASE MANAGEMENT SYSTEM

A management platform on the basis of Internet is needed to construct from a long-term perspective to realize the management for quantities of large public buildings, including the operational parameters and energy consumption of energy-consuming equipments. The database management system is established based on the local server in the paper to realize the management of energy consumption for a

¹ supported by National natural foundation of china (50578049)

small quantity of buildings. The connection with Internet and the interface with monitoring system need to be considered based on this paper to establish the energy consumption network database management system for large public buildings eventually.

This database in this paper is used to manage several public buildings and realize the energy consumption statistic for air-conditioning, heating and lighting systems, which covers all kinds of public buildings. The design of database management system includes two parts: database designing and application designing.

3. DESIGN OF DATABASE SYSTEM

The common database models are: hierarchy model, reticulated model, relation model and object oriented model. The relation model is used taking account of the character of each model. The regular design method is used in the design of database, and the whole developing process is divided into six phase: (1) demand analysis; (2) conception structure design; (3) logic structure design; (4) physical structure design; (5) the implementation of database; (6) running and maintenance of database. Continuous repeat of the six phases is needed in the design process of a perfect database application system.

SQL Server 2000 is used as the database system and PowerBuilder10.0 is used as the developing tool for the application of this database, by the comparison of kinds of database systems and developing tools^[9, 10].

3.1 Demand Analysis of Database

The demand analysis is to analyze the demand of users, which has direct influence on each design phase afterward. The database faces the researchers and building owners mainly, and is used in the measurement, evaluation and management of building energy consumption. It is convenient to input data for users and query for the basic information of buildings, the designing and operational parameters of energy-consuming equipments, and evaluate the operational energy efficiency of air-conditioning and heating systems, also, make statistical management for each item of

building energy.

3.2 Conception Structure Design of Database

The conception structure design is a process abstracting the demands of users got from demand analysis to the information structure (conception model). The most useful tool describing the conception model is E-R model, namely Entity-Relationship. The E-R figures of general and entity are showed in Fig.1~2.

3.3 Logic Structure Design of Database

The task of logic structure design is transforming the basic E-R figure designed in the phase of conception structure design to logic structure according with the database model supported by chosen DBMS product. As the relation model is used in this database, a series of two-dimensional tables are got by transforming the conception model to relation structure model. Each two-dimensional table contains five parts: item's name, data type, length, setting up primary key, explanation.

3.4 The Establishment and Implementation of Database

SQL Server2000 is used as database and local computer is used as server. At first, a SQL Server register is established so as to connect to the database server. Then, the database is established on the server which has been set. Next, each data table is set using table designer, and the relevant primary key is defined. The view is built on the basis of tables. The implementation phase contains data inputting, making and debugging the application. As the application of database and the database are designed synchronously, the debugging of application is needed when inputting the data into the database. The data are input manually by basic table in the process of establishment of database. The data can input directly though application by administrator when the database and application system is designed completely.

4. THE DEVELOPMENT OF APPLICATION FOR THE DATABASE MANAGEMENT

SYSTEM

4.1 The Structure and Functions of the Database Management System

This system includes 9 parts, 34 complete modules, as showed in Fig.3. The querying and statistic of

basic information of buildings, designing and operational parameters of energy-consuming equipments, the energy consumption of equipment and system can be realized by this system, and the evaluation of energy efficiency for equipment and system can be accomplished.

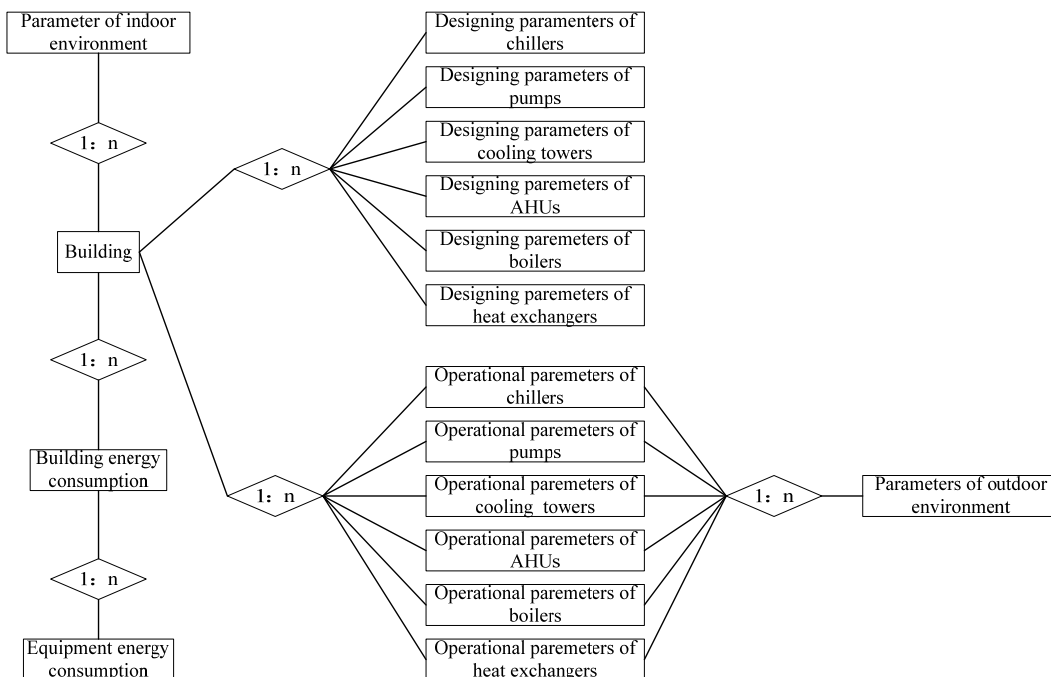


Fig.1 General E-R figure

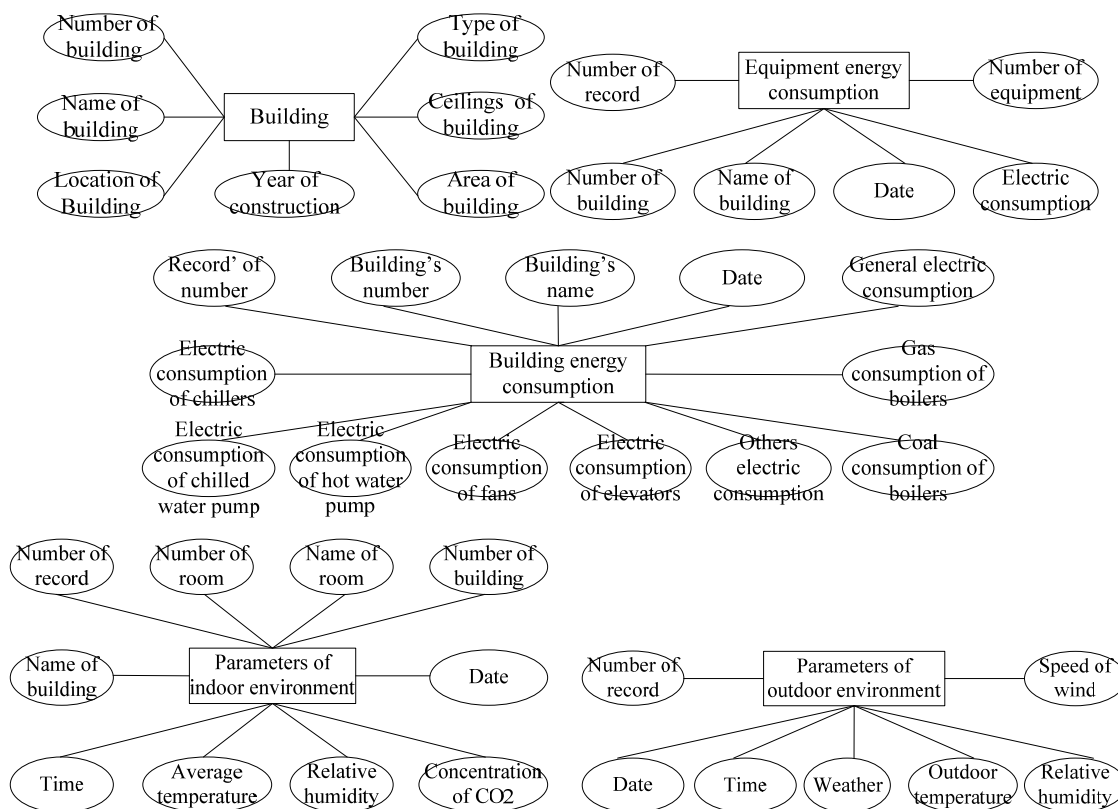


Fig.2 E-R figures of entities

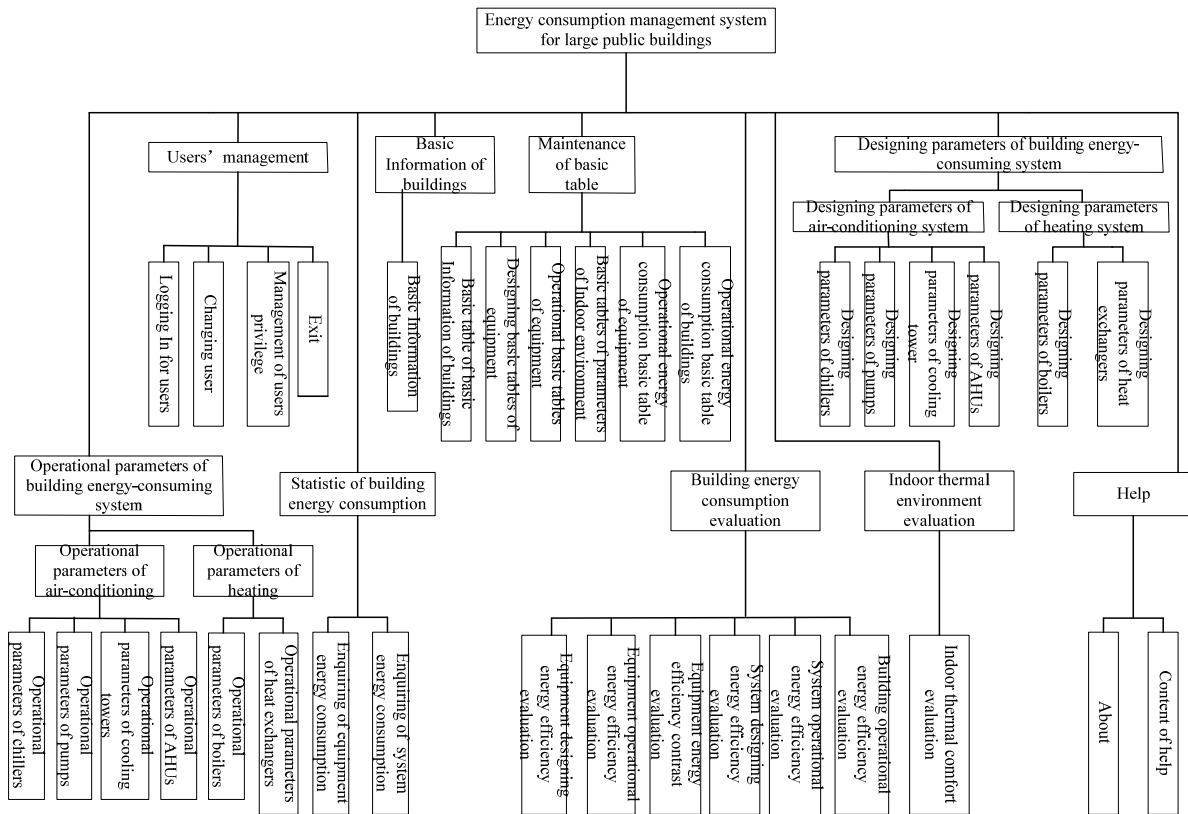


Fig.3 The structure of energy consumption database management system for large public buildings

4.2 Application Design

The object oriented programming method is used in the process of development, which focus main actions on the building up the connection between the object and object. The application is made up of a series of objects in PowerBuilder, such as window, menu, function, structure, data window and other general objects. Each object has some characters and actions (attribute, event and function), and these objects can be used repeated so as to improve the efficiency and shorten the developing time. The basic designing flow of this application is showed as Fig.4,

which mainly contains the main interface design, menu design, users management window design, basic table maintenance window design, window design of the basic information of building, window design of the designing and operational parameters of energy-consuming system of building, window design of statistic of building energy consumption, window design of evaluation for building energy consumption, window design of evaluation for indoor thermal environment. The main interface of the system is showed as in Fig.5, the other key windows

are showed in Fig.6~Fig.8.

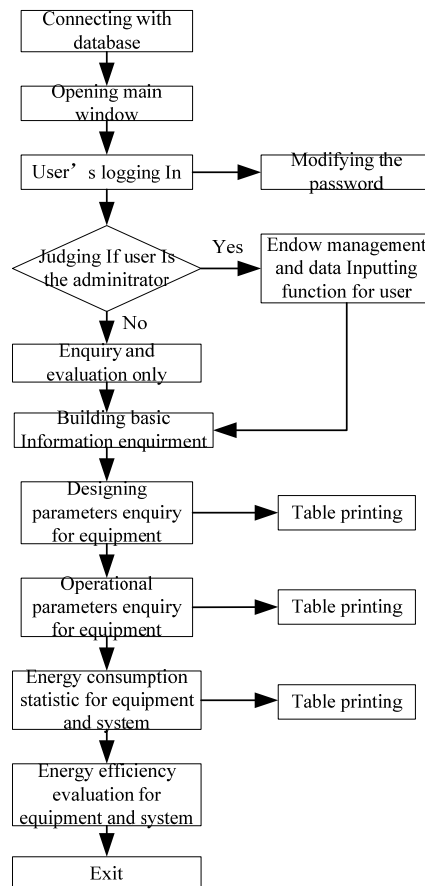


Fig.4 General design flow chart

5. CONCLUSION

The develop process of operational energy consumption database management system for large public buildings is introduced in this paper, which contains the database design and the application design. This database has several characters as followed:

- 1) The database management system is accomplished with the background of operational energy consumption measurement for large public buildings. The efficiency of measurement of building energy consumption and the diagnosis of energy efficiency can be improved, and effective management of measured data can be realized by this system.
- 2) The measurement data can be saved and managed by the types of buildings and equipment, and by the date of measurement. The designing and operational parameters of single and multi equipments and buildings can be queried conveniently though different ways.
- 3) The calculation of energy efficiency indexes can be finished automatically by database, so the work of dealing with data can be reduced.

In the process of development of whole database management system, some issues deserved to be paid attention to:

- 1) The demand analysis is very important to the establishment of database.
- 2) The database is completed perfectly though each phase's repeated adjustment and local modification. The database design and the application design are supplemented each other.
- 3) The application should be designed with the principle of easy manipulation, practicality and friendly interface, and should realize the aim of demand analysis.

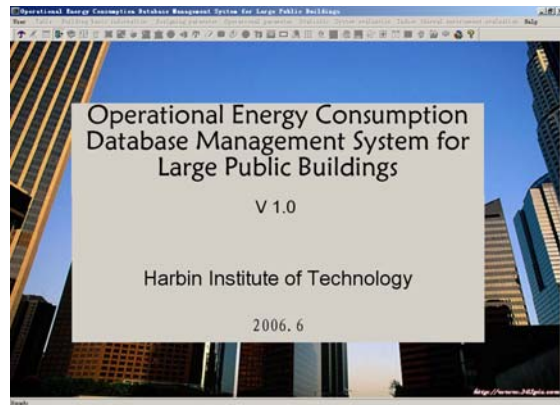


Fig.5 The main interface of system

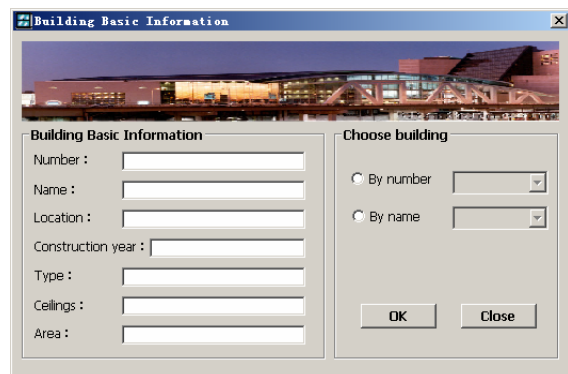


Fig.6 Querying of buildings basic information

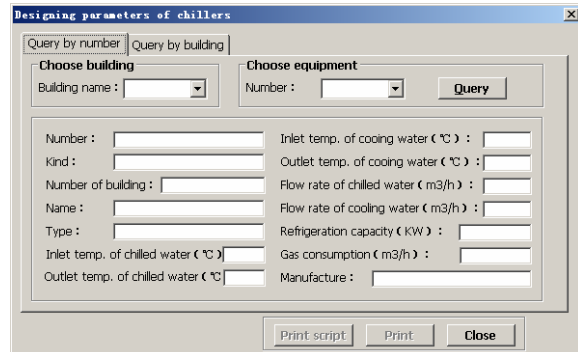


Fig.7 Querying of designing parameters of chillers

Fig.8 The evaluation of designing energy efficiency for equipment

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