Chapter 16

Methodology

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Conceptual Database Design

Design Methodology

- **Structured approach that uses procedures, techniques, tools, and documentation aids to support and facilitate the process of design**

- **Three main phases**
  - **Conceptual database design**
  - **Logical database design**
  - **Physical database design**

Conceptual Database Design

- The process of constructing a model of the data used in an enterprise, independent of *all* physical considerations and any data model to be used
- To build the conceptual representation of the database, which includes identification of the important entities, relationships, and attributes
- We use the Entity–Relationship (ER) modeling technique to create the *conceptual data model*

Logical Database Design

- The Process of constructing model of data used in an enterprise based on a specific **data model**, but independent of particular **DBMS and other physical considerations**
- The translation of conceptual representation to the logical structure of the database includes **designing the relations**

Physical Database Design

- To decide how the logical structure is to be physically implemented (**as base relations**) in the target Database Management System (DBMS)
- The Process of producing description of implementation of database on secondary storage
  - Describes base relations, file organizations, and indexes
  - Design used to achieve efficient access to data, and any associated integrity constraints and security measures

Conceptual database design

- **Step 1 Build conceptual data model**
  - Step 1.1 Identify entity types
  - Step 1.2 Identify relationship types
  - Step 1.3 Identify and associate attributes with entity or relationship types
  - Step 1.4 Determine attribute domains
  - Step 1.5 Determine candidate, primary, and alternate key attributes
  - Step 1.6 Consider use of enhanced modeling concepts
  - Step 1.7 Validate conceptual data model against user transactions
  - Step 1.8 Validate conceptual data model with user

Logical Database Design for the Relational Model

- **Step 2 Build logical data model**
  - Step 2.1 Derive relations for logical data model
  - Step 2.2 Validate relations using normalization
  - Step 2.3 Check integrity constraints

Physical Database Design for Relational Databases

- Step 3 Translate logical data model for target DBMS
  - Step 3.1 Design base relations
  - Step 3.2 Design representation of derived data
  - Step 3.3 Design general constraints
- Step 4 Design file organizations and indexes
  - Step 4.1 Analyze transactions
  - Step 4.2 Choose file organizations
  - Step 4.3 Choose indexes
  - Step 4.4 Estimate disk space requirements
- Step 5 Design user views
- Step 6 Design security mechanisms

Step 1 Build Conceptual Data Model

- **Step 1.1 Identify entity types**
  - **To identify required entity types**
    - **Typically nouns, noun phrases, major objects**
    - **Document Entity Types in Data Dictionary**

Document Entity Types

- The conceptual data model is supported by documentation, including ER diagrams and a data dictionary, which is produced throughout the development of the model
- Record the names and descriptions of entities in a data dictionary.
- If possible, document the expected number of occurrences of each entity.
- If an entity is known by different names, the names are referred to as synonyms or *aliases*, which are also recorded in the data dictionary
- Figure on next slide shows an extract from the data dictionary

Document Entity Types

Extract from data dictionary for *DreamHome* example showing description of entities

Entity name	*Description*	*Aliases*	*Occurrence*
Staff	General term descr bing al staff employed by *DreamHome*.	Employee	Each member of staff works at one particular branch.
PropertyForRent	General term descr bing all property for rent.	Property	Each property has a s ngle owner and is available at one specific branch, where the property is managed by one member of staff. A property is viewed by many clients and rented by a single client, at any one time.

Step 1 Build Conceptual Data Model (Cont'd)

- **Step 1.2 Identify relationship types**
  - **To identify important relationships that exist between entity types**
    - **Typically verbs, verb phrases**
    - **Determine multiplicity constraints**
    - **Document Relationship Types in Data Dictionary**
    - **Use ER modeling to visualize the entity and relationships**

Document Relationship Types
Extract from data dictionary for *DreamHome* example showing description of relationships

Entity name	*Multiplicity*	*Relationship*	*Multiplicity*	*Entity name*
Staff	0..1 0..1	*Manages* *Supervises*	0..100 0..10	**PropertyForRent** **Staff**
PropertyForRent	1..1	*AssociatedWith*	0..*	**Lease**

Use ER modeling to visualize the entity and relationships

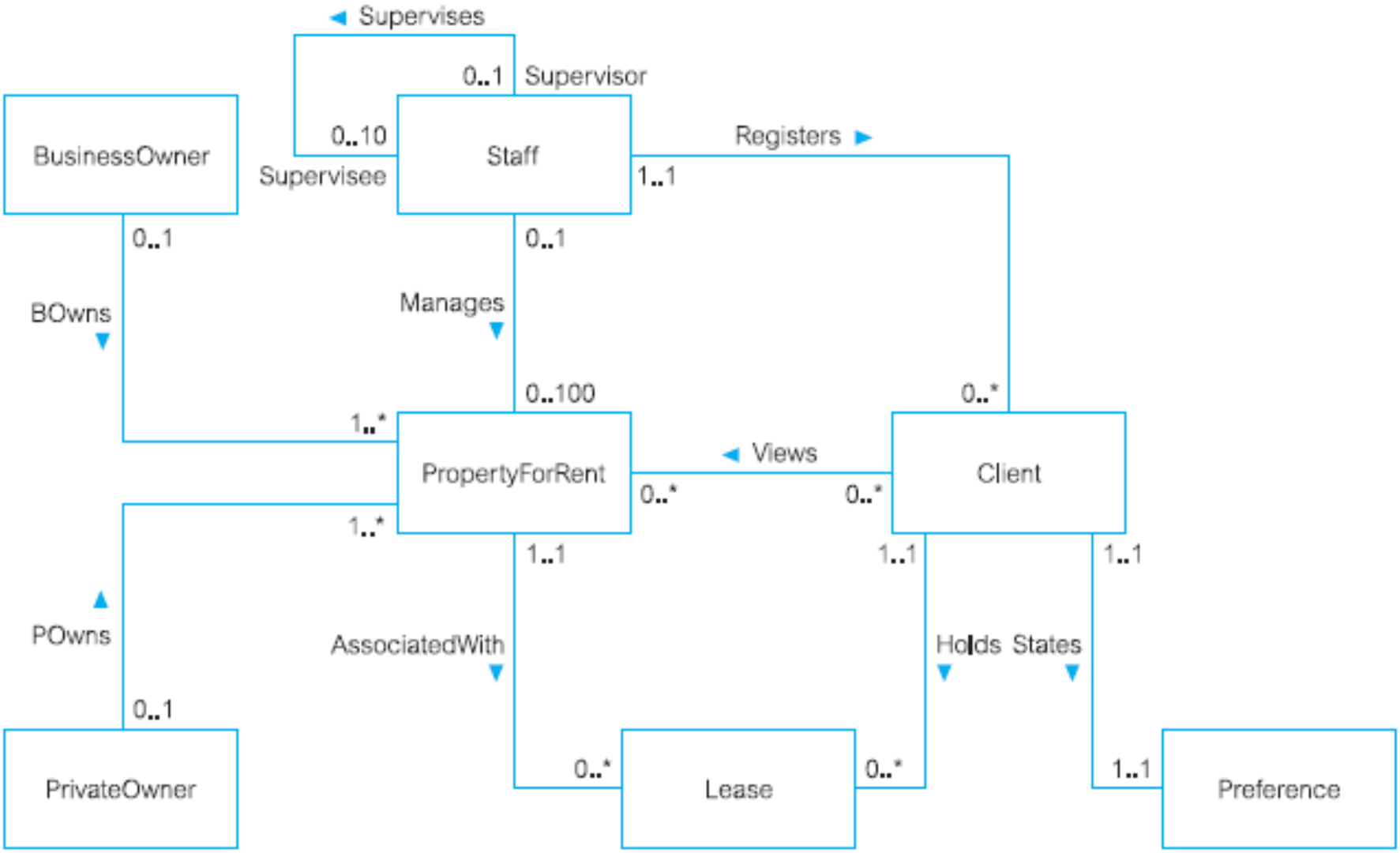

Figure 16.2 First-cut ER diagram showing entity and relationship types for the StaffClient user views of *DreamHome*.

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.3 Identify and associate attributes with entity or relationship types**
  - **To associate attributes with appropriate entity or relationship types**
    - **Identify simple/composite attributes**
    - **Identify single/multi-valued attributes**
    - **Identify derived attributes**
    - **Document details of each attribute in Data Dictionary**

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.4 Determine attribute domains**
  - **To determine domains for attributes in data model and document details of each domain**

Extract from data dictionary for *DreamHome* example showing description of attributes

Entity name	*Attributes*	*Description*	*Data Type & Length*	*Nulls*	*Multi-valued*	...
Staff	**staffNo**	Unique y identifies a member of staff	5 variable characters	No	No	
	name					
	fName	First name of staff	15 variable characters	No	No	
	lName	Last name of staff	15 variable characters	No	No	
	position	Job title of member of staff	10 variable characters	No	No	
	sex	Gender of member of staff	1 character (M or F)	Yes	No	
	DOB	Date of birth of member of staff	Date	Yes	No	
PropertyForRent	**propertyNo**	Unique y identifies a property for rent	5 variable characters	No	No	

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.5 Determine candidate, primary, and alternate key attributes**
  - **To identify candidate key(s) for each entity and if there is more than one candidate key, to choose one to be primary key and others as alternate keys**
    - **Record the identification of primary, and any alternate keys in the data dictionary**

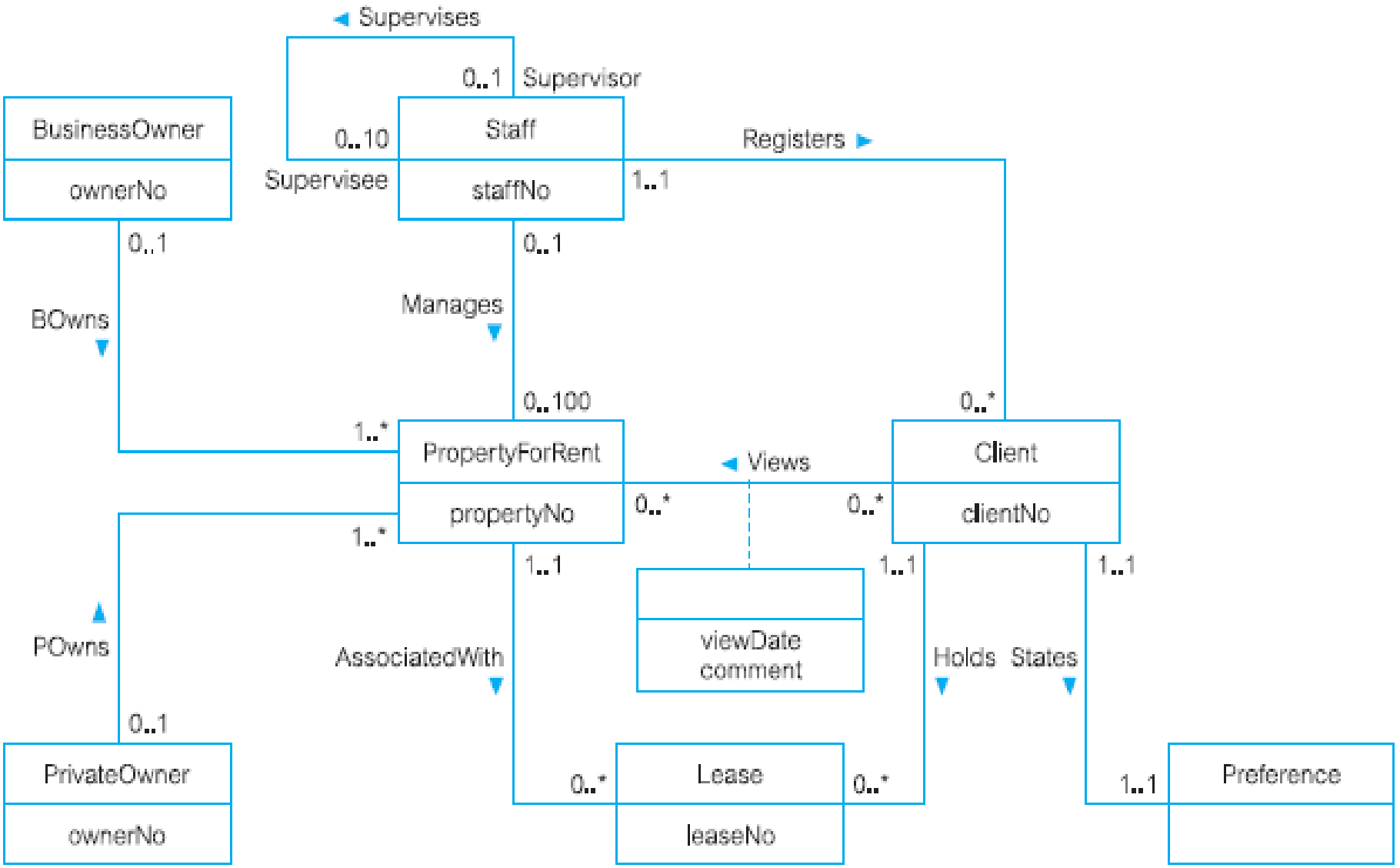

Figure 16.5 ER diagram for the StaffClient user views of *DreamHome* with primary keys added.

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.6 Consider use of enhanced modeling concepts (Optional Step)**
  - **To consider the use of enhanced modeling concepts, such as specialization / generalization**

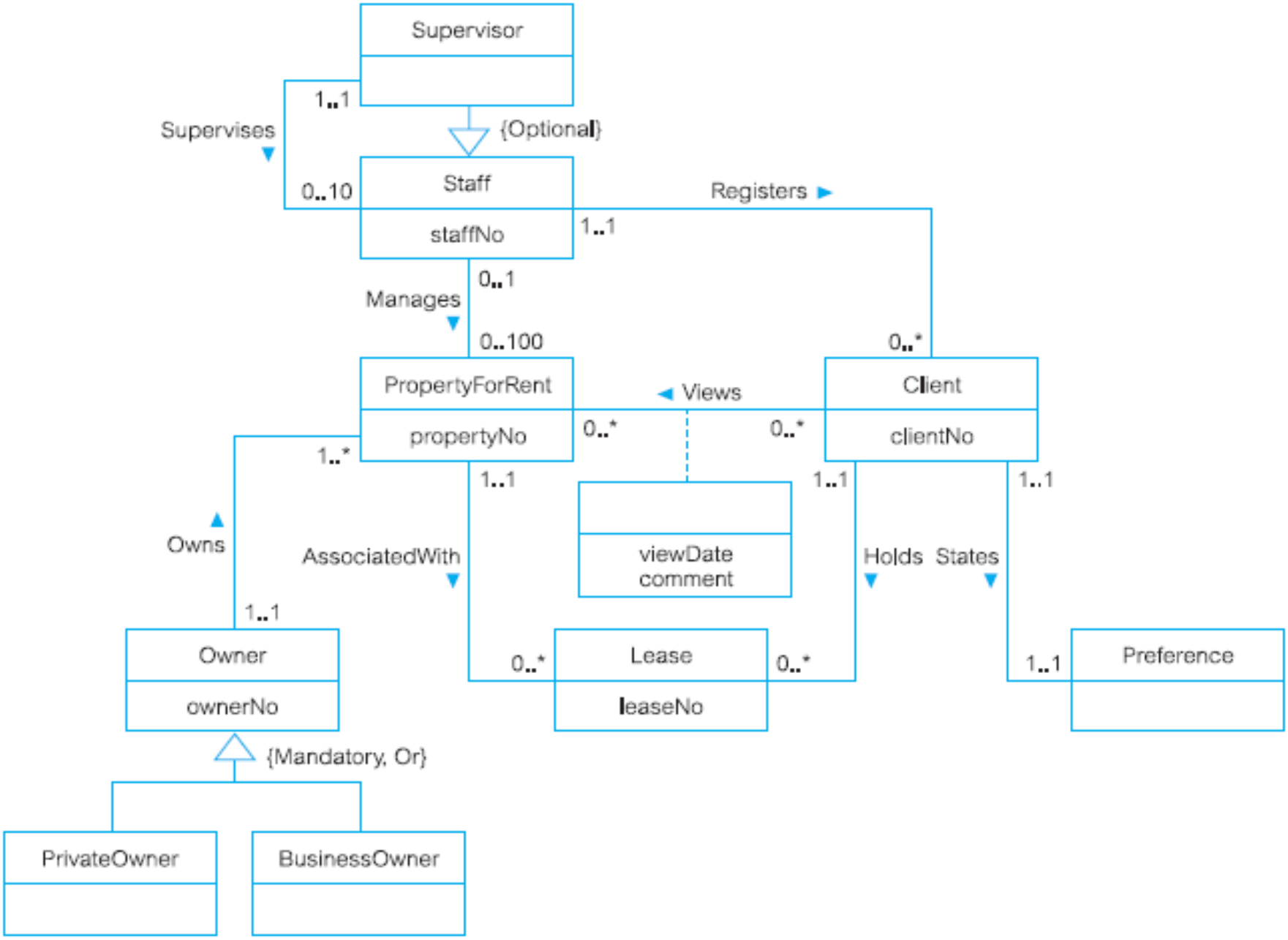

Figure 16.6 Revised ER diagram for the StaffClient user views of *DreamHome* with specialization/generalization added.

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.7 Validate conceptual data model against user transactions**
  - **To ensure that the conceptual data model supports the required transactions**
    - **Use transaction pathways**

Data queries

Examples of queries required by the Staff user views:

(a) List details of staff supervised by a named Supervisor at the branch.

(b) List details of all Assistants alphabetically by name at the branch.

(c) List the details of property (including the rental deposit) available for rent at the branch, along with the owner's details.

(d) List the details of properties managed by a named member of staff at the branch.

(e) List the clients registering at the branch and the names of the members of staff who registered the clients.

(f) Identify properties located in Glasgow with rents no higher than £450.

(g) Identify the name and telephone number of an owner of a given property.

(h) List the details of comments made by clients viewing a given property.

(i) Display the names and phone numbers of clients who have viewed a given property but not supplied comments.

(j) Display the details of a lease between a named client and a given property.

(k) Identify the leases due to expire next month at the branch.

(l) List the details of properties that have not been rented out for more than three months.

(m) Produce a list of clients whose preferences match a particular property.

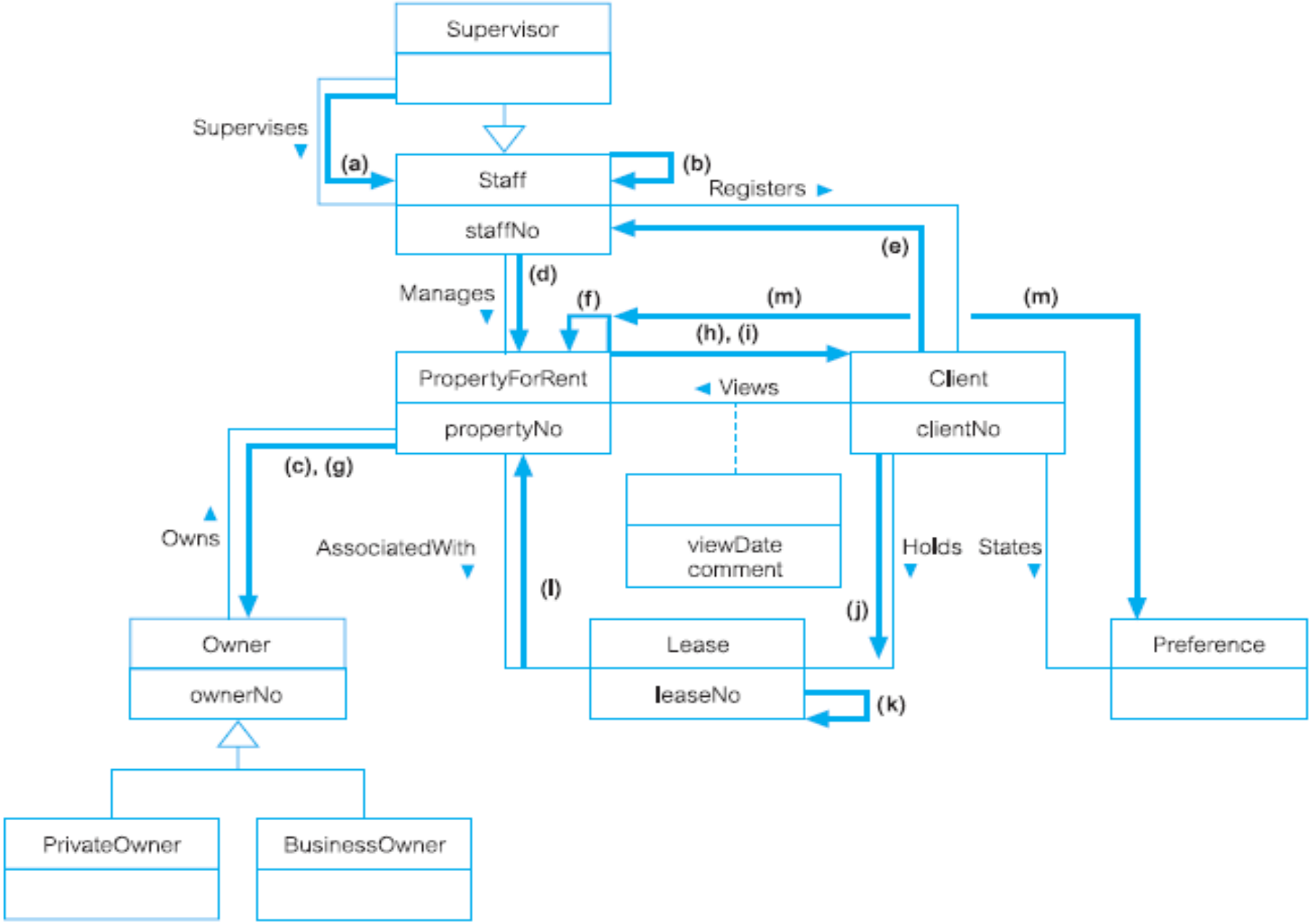

Figure 16.9 Using pathways to check whether the conceptual data model supports the user transactions.

Step 1 Build Conceptual Data (Cont'd)

- **Step 1.8 Validate conceptual data model with user**
  - **To review the conceptual data model with the users to ensure that they consider the model to be a "true" representation of the data requirements of the enterprise**

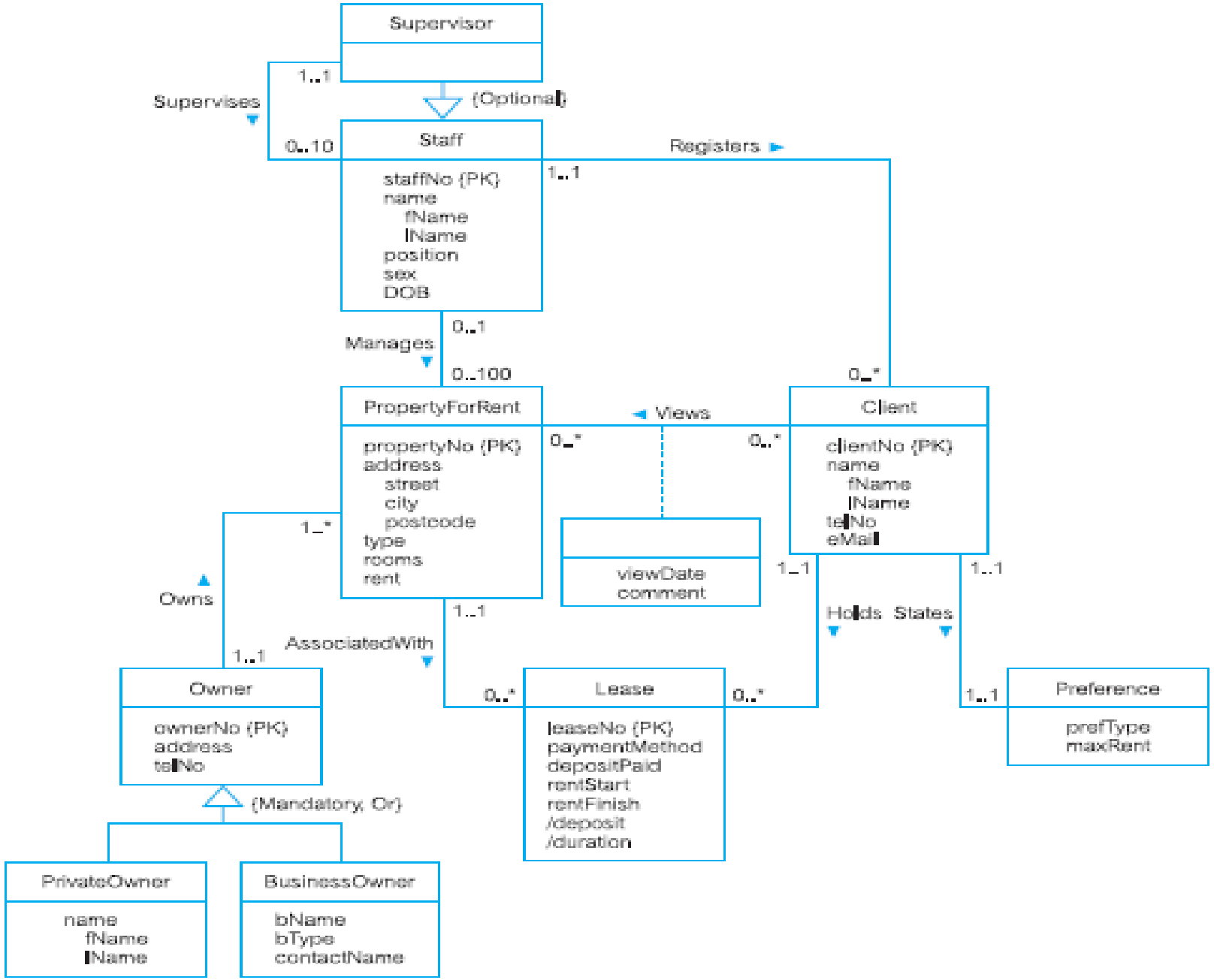

Figure 17.1 Conceptual data model for the StaffClient user views showing all attributes.

Conceptual Data Model of all Users' Views