

Data Model Suggestions

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Data Model Suggestions

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Description: Database architecture and data model recommendations

Data Model Suggestions for ADPA (Advanced Document Processing & Automation Framework)

1. Entity Relationship Analysis

1.1 Core Business Entities

Based on the requirements, the following primary entities are identified:

- **User:** End users including admins, analysts, project managers, stakeholders, etc.
- **Team:** Groups of users collaborating on projects.
- **Project:** High-level workspaces for managing document generation, templates, and workflows.
- **Document:** Generated outputs (PDF, Markdown, etc.) and associated metadata.
- **Template:** Document templates compliant with BABOK, PMBOK, DMBOK, etc.
- **Framework:** Supported standards (BABOK v3, PMBOK 7, DMBOK 2.0).
- **AI Provider:** Registered AI backends (OpenAI, Google AI, etc.).
- **Integration:** External system connections (Confluence, SharePoint, Adobe, etc.).
- **Job:** Asynchronous document generation or conversion operations.
- **Role:** Permission grouping for RBAC.
- **Permission:** Granular access rights.
- **Audit Log:** Security and compliance event tracking.

1.2 Entity Relationships & Cardinality

- **User ↔ Team:** Many-to-many (users can belong to multiple teams; teams have multiple users).
- **Team ↔ Project:** One-to-many (a team owns many projects; a project belongs to one team).
- **User ↔ Project:** Many-to-many (for sharing or access control beyond teams).
- **Project ↔ Document:** One-to-many (project contains documents).
- **Document ↔ Template:** Many-to-one (each document is generated from a template).
- **Template ↔ Framework:** Many-to-one (templates are linked to a standard).
- **Project ↔ Integration:** Many-to-many (projects may have multiple integrations).
- **User ↔ Role:** Many-to-many (users can have multiple roles).
- **Role ↔ Permission:** Many-to-many (RBAC).

- **Document** ↔ **Job**: One-to-many (a document may have multiple jobs for generation/updates).
- **AI Provider** ↔ **Job**: One-to-many (track which AI provider handled which job).
- **User** ↔ **Audit Log**: One-to-many (user triggers logs).

1.3 Key Attributes

User

- id (PK, UUID)
- username (unique)
- email (unique)
- hashed_password
- status (active, suspended, etc.)
- created_at, updated_at

Team

- id (PK, UUID)
- name
- description
- created_at, updated_at

Project

- id (PK, UUID)
- team_id (FK)
- name
- description
- status (active, archived)
- created_at, updated_at

Document

- id (PK, UUID)
- project_id (FK)

- template_id (FK)
- name
- format (pdf, docx, md, etc.)
- content_url / file_path
- version
- status (draft, published, archived)
- created_at, updated_at

Template

- id (PK, UUID)
- framework_id (FK)
- name
- description
- category
- content (JSON/Markdown/HTML)
- variables (JSON)
- created_by (FK User)
- created_at, updated_at

Framework

- id (PK, UUID)
- code (babok, pmbok, dmbok)
- name
- description
- version

AI Provider

- id (PK, UUID)
- name
- provider_type (openai, google, etc.)
- config_json
- status (active, deprecated)
- created_at, updated_at

Integration

- id (PK, UUID)
- type (confluence, sharepoint, adobe, vcs, etc.)
- config_json
- status
- created_at, updated_at

Job

- id (PK, UUID)
- document_id (FK)
- ai_provider_id (FK)
- type (generation, conversion, etc.)
- status (pending, running, completed, failed)
- result_url
- started_at, completed_at

Role

- id (PK, UUID)
- name
- description

Permission

- id (PK, UUID)
- resource
- action

Audit Log

- id (PK, UUID)
- user_id (FK)
- action
- resource
- resource_id
- timestamp

- details (JSON)

1.4 Primary & Foreign Keys

- PK: All `id` fields (UUID).
 - FK: As indicated above (e.g., `project.team_id` → `team.id`).
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2. Data Model Recommendations

2.1 Logical Data Model Structure

- Use a **relational model** for core business entities (users, teams, projects, documents, templates, frameworks, RBAC).
- Store large document/template content as external objects (object storage or BLOB columns), reference via URLs/file paths.
- Store AI provider and integration configurations as JSON/BLOB columns for flexibility.
- Use **junction tables** for:
 - `user_team` (`user_id`, `team_id`, `role_id`, `joined_at`)
 - `user_role` (`user_id`, `role_id`)
 - `role_permission` (`role_id`, `permission_id`)
 - `project_integration` (`project_id`, `integration_id`)
 - `user_project` (`user_id`, `project_id`, `role_id`)

2.2 Physical Implementation Considerations

- Prefer **UUIDs** for primary keys for distributed scalability and security.
- For high concurrency (collaboration, real-time editing), consider optimistic locking/versioning on Document.
- For audit and compliance, dedicate a write-optimized log table (partitioned by date).
- Use **PostgreSQL** or **Azure SQL** for core data; consider **NoSQL** (Cosmos DB, MongoDB) for audit logs or versioned document content if needed.

2.3 Normalization Recommendations

- Normalize up to 3NF for core operational tables (avoid redundant data, simplify updates).
- Denormalize for read-heavy analytics/reporting tables as appropriate (materialized views for dashboards).
- Store large/unstructured template content as external BLOB (S3, Azure Blob) and reference via URL if size becomes an issue.

2.4 Index Strategy Suggestions

- Unique indexes on all natural keys: username, email, team name, project name (scoped to team), template name (scoped to framework).
 - Composite indexes for frequent queries:
 - (project_id, status) on Document
 - (team_id, status) on Project
 - (user_id, team_id) on user_team
 - (role_id, permission_id) on role_permission
 - (document_id, status) on Job
 - GIN/JSONB indexes for querying into config_json or variables columns.
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3. Database Design Guidelines

3.1 Table Structure Recommendations

- Use **singular, lower_snake_case** table names: user, team, project, document, template, framework, ai_provider, integration, job, role, permission, audit_log.
- Use **junction tables** for all many-to-many relationships, include audit fields (created_at, updated_at).
- For versioned documents/templates, add: version (integer), previous_version_id (FK).

3.2 Data Type Selections

- UUIDs for all PKs and FKs.
- VarChar(255) for names, emails, and slugs.
- Text/BLOB for large content (documents, templates).
- JSONB for config and variable fields.
- Enum types for status fields (where supported).
- Timestamps (with timezone) for all created_at, updated_at, etc.

3.3 Constraint Definitions

- **NOT NULL** on all required fields.
- **UNIQUE** on all natural keys (username, email, etc.).
- **FOREIGN KEY** constraints with ON DELETE CASCADE/SET NULL as appropriate.
- **CHECK** constraints for enums (status, type).
- **Default values** for status, created_at, updated_at.

3.4 Performance Optimization Strategies

- Partition large tables (audit_log, job) by date or project for fast querying and archival.
- Use read replicas for analytics/reporting workloads.
- Implement connection pooling.
- Periodically archive or purge historical document/job/audit data.
- Use caching (Redis) for frequently accessed metadata (frameworks, templates).
- Consider database-level encryption for sensitive columns (PII, API keys).

4. Data Governance Framework

4.1 Data Quality Standards

- Enforce schema validation at the API and DB layer.

- Require all core fields (names, emails, document/template metadata) to be populated.
- Use referential integrity for all FKs.
- Automate duplicate detection for templates, projects, documents.

4.2 Data Validation Rules

- Validate email format, password strength, and unique usernames on user creation.
- Enforce allowed file formats during document upload/generation.
- Check that referenced templates/frameworks exist before document generation.
- Validate JSON config fields using JSON schema validation libraries (AJV, Joi).

4.3 Data Security Considerations

- Use salted hash (bcrypt) for password storage.
- Store API tokens/credentials encrypted at rest.
- Apply RBAC at the database and application layers.
- Log all access to sensitive data in the audit log.
- Implement row-level security (PostgreSQL RLS) for multitenancy if needed.
- Use database encryption (TDE) for persistent storage.
- Mask PII in logs and exports.

4.4 Backup & Recovery Strategies

- Daily full backups, hourly incrementals for core DB.
 - Store backups in geographically redundant storage (Azure, AWS).
 - Point-in-time recovery enabled for production environments.
 - Regular test restores to validate backup integrity.
 - Retention policy: 30 days standard, 7 years for audit/compliance logs.
 - Store versioned documents/templates for rollback.
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Summary Table: Entity Overview

Entity	Description	PK	Key Relationships
User	System user	id (UUID)	Team (M:M), Project (M:M), Role (M:M)
Team	Group of users	id (UUID)	User (M:M), Project (1:M)
Project	Workspace for documents/templates	id (UUID)	Team (M:1), User (M:M), Document (1:M)
Document	Generated output	id (UUID)	Project (M:1), Template (M:1), Job (1:M)
Template	Document blueprint	id (UUID)	Framework (M:1), Document (1:M)
Framework	Standard (BABOK, PMBOK, etc.)	id (UUID)	Template (1:M)
AI Provider	AI backend configuration	id (UUID)	Job (1:M)
Integration	External system connection	id (UUID)	Project (M:M)

Entity	Description	PK	Key Relationships
Job	Processing task (generation, conversion)	id (UUID)	Document (M:1), AI Provider (M:1)
Role	RBAC grouping	id (UUID)	User (M:M), Permission (M:M)
Permission	Access right on resource	id (UUID)	Role (M:M)
Audit Log	Security & compliance event	id (UUID)	User (M:1)

Closing Notes

- This model provides a scalable, extensible foundation for ADPA's document processing, automation, and enterprise integration needs.
 - It aligns with industry best practices for security, compliance, and maintainability.
 - The design supports both immediate project requirements and long-term enterprise growth (multi-tenancy, high concurrency, auditability, and integration extensibility).
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Next Steps:

- Review entity relationships with business/product owners.
- Prioritize implementation of core tables and RBAC.
- Prototype schema using PostgreSQL or Azure SQL.
- Validate with integration and API use cases.

- Establish data validation and governance processes early.

End of Data Model Suggestions

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