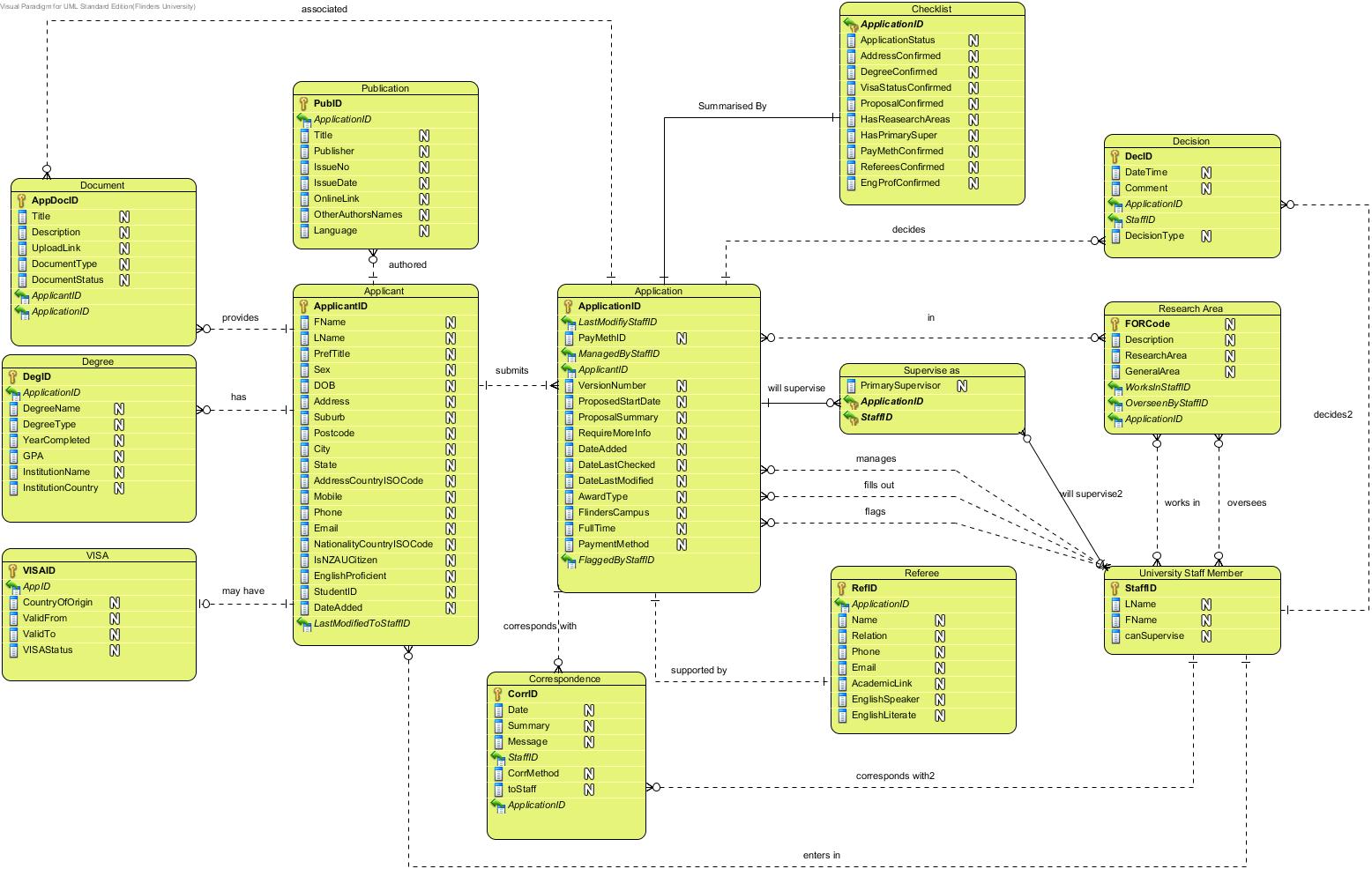
## Derive relations

### Conceptual E-R diagram



### Strong Entity types

|  |
| --- |
| **Applicant** (ApplicantID, FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, Country, Mobile, Phone, Email, Nationality, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID)  **Primary key** ApplicantID |
| **Application** (ApplicationID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, AwardType, flindersCampus, fullTime, PaymentMethod)  **Primary key** ApplicationID |
| **Correspondence** (CorrID, Date, Summary, Message, CorrMeth, toStaff)  **Primary key** CorrID |
| **Decision** (DecID, DateTime, Comment, DecisionType)  **Primary key** DecID |
| **Degree** (DegID, DegreeName, DegreeType, YearCompleted, GPA, InstitutionName, InstituitonCountry)  **Primary key** DegID |
| **Document** (DocID, UploadLink, DocStatus, DocumentType, Title, Description)  **Primary key** UploadLink |
| **Publication** (PubID, ApplicantID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language)  **Primary key** PubID |
| **Referee** (RefID, Name, Relation, Phone, Email, AcademicLink, EnglishSpeaker, EnglishLiterate)  **Primary key** RefID |
| **Research Area** (FORCode, Description, ResearchArea, GeneralArea)  **Primary key** FORCode |
| **University Staff Member** (StaffID, FName, LName, canSupervise)  **Primary key** StaffID |
| **Visa** (VisaID, VISAStatus, CountryOfOrigin, ValidFrom, ValidTo)  **Primary key** VisaID |

### Weak Entity types

|  |
| --- |
| **Checklist** (ApplicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchArea, HasPrimarySuper, PayMethConfirmed, RefrereesConfirmed, EngProfConfirmed)  **Primary key** None (at this stage) |
| **Supervise as** (PrimarySupervisor)\*  **Primary key** None (at this stage) |

\* This entity was created during the conceptual phase to remove a relationship attribute

Very few natural alternate keys were found as many attributes are nullable due the limited information received at the time of initial user entry.

### One-to-many binary relationships

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| associated | No | Application | 0..1 | ApplicationID | Document | 0..\* |
| authored | No | Applicant | 1..1 | ApplicantID | Publication | 0..\* |
| corresponds with | No | Application | 1..1 | ApplicationID | Correspondence | 0..\* |
| corresponds with2 | No | University Staff Member | 1..1 | StaffID | Correspondence | 0..\* |
| decides | No | Application | 1..1 | ApplicationID | Decision | 0..\* |
| decides2 | No | University Staff Member | 1..1 | StaffID | Decision | 0..\* |
| has | Yes | Applicant | 1..1 | ApplicantID | Degree | 0..\* |
| last to modify |  | University Staff Member | 1..1 | StaffID → LastToModifyStaffID | Applicant | 0..\* |
| last to update | No | University Staff Member | 1..1 | StaffID →LastToModifyStaffID | Application | 0..\* |
| manages | No | University Staff Member | 0..1 | StaffID → ManagedByStaffID | Application | 0..\* |
| provides | No | Applicant | 1..1 | ApplicantID | Document | 0..\* |
| submits | Yes | Applicant | 1..1 | ApplicantID | Application | 0..\* |
| supported by | No | Application | 1..1 | ApplicationID | Referee | 1 |
| will supervise | Yes | Application | 1..1 | ApplicationID | Supervise as | 0..\* |
| will supervise2 | Yes | University Staff Member | 1..1 | StaffID | Supervise as | 0..\* |

Included in the relations of section 1.2 this becomes

|  |
| --- |
| **Applicant** (ApplicantID, FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, AddressCountryISOCode, Mobile, Phone, Email, NationalityCountryISOCode, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID)  **Primary key** ApplicantID  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID) |
| **Application** (ApplicationID, applicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, awardType, flindersCampus, fullTime, paymentMethod)  **Primary key** ApplicationID  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** ManagedByStaffID **references** University Staff Member(StaffID) |
| **Application\_Research Area** (ApplicationID, FORCode)  **Primary key** ApplicationID, FORCode  **Foreign key** ApplicantID **references** Application(ApplicationID) |
| **Correspondence** (CorrID, Date, Summary, Message, ApplicantID, StaffID, CorrMeth, toStaff  **Primary key** CorrID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID) |
| **Decision** (DecID, Date, Comment, ApplicationID, StaffID, decType)  **Primary key** DecID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID) |
| **Degree** (DegID, ApplicantID, Name, Type, YearCompleted, GPA, InstitutionName, InstitutionCountryISOCode)  **Primary key** DegID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Document** (DocID, UploadLink, Title, Description, DocType, DocStat, ApplicantID, ApplicationID)  **Primary key** UploadLink  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Publication** (PubID, ApplicantID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language)  **Primary key** PubID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Referee** (RefID, ApplicationID, Name, Relation, Phone, Email, AcademicLink, EnglishSpeaker, EnglishLiterate)  **Primary key** RefID  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Research Area** (FORCode, Description, ResearchArea, GeneralArea) UNCHANGED  **Primary key** FORCode |
| **Supervise as** (StaffID, ApplicationID, PrimarySupervisor)  **Primary key** StaffID, ApplicationID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** University Staff Member(StaffID) |
| **University Staff Member** (StaffID, FName, LName, canSupervise) UNCHANGED  **Primary key** StaffID |
| **Visa** (VisaID, ApplicantID, OriginCountryISOCode, VISAStatus, ValidFrom, ValidTo) UNCHANGED  **Primary key** VisaID |

### One-to-one binary relationships

#### Mandatory on both sides

For the **Application *summarised by* Checklist** relationship, we bring all the attributes of **Checklist** into **Application**. The primary key remains ApplicationID; **Checklist** was a weak entity and never had a primary key. The **Checklist** relation is therefore dropped and the Application relation becomes

|  |
| --- |
| **Application** (ApplicationID, ApplicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, AwardType, PaymentMethod, flindersCampus, fullTime)  **Primary key** ApplicationID |

All other relations are as were in the previous section (1.4)

**Removed the following possible relationships:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| Summarised by | Yes | Application | 1 | ApplicationID | Checklist | 1 |

#### Mandatory on one side

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| may have | No | Applicant | 1 | ApplicantID | VISA | 0..1 |

The Visa application relation becomes

|  |
| --- |
| **Visa** (VisaID, ApplicantID, OriginCountryISOCode, VISAStatus, ValidFrom, ValidTo)  **Primary key** VisaID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |

#### Optional on both sides

None in this case.

### One-to-one recursive relationships

None in this case.

### Superclass/subclass relationships

The following subclass/superclass relationship was removed at the conceptual phase due to the limitations of the modelling program not being able to handle such relationships.

University Staff member -> RHD staff member

-> Professional academic staff member (who can supervise)

-> general academic staff member (cant supervise)

In this case the three child relations were merged into when with a ‘can supervise’ discriminator added. The distinction between a RHD staff member and a general staff member was found not to be needed and thusly dropped though if required a second discriminator such as ‘is RHD manger’ can be added . This resulted in the formation of the university staff member relation:

|  |
| --- |
| **University Staff Member** (StaffID, FName, LName, canSupervise)  **Primary key** StaffID |

With all other relations remain as per the previous sections

### Many-to-many binary relationship types

#### University Staff Member works in Research Area

Introduce the following relation:

|  |
| --- |
| **University Staff Member\_Research Area** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |

Introduce the following relationships:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| works in | Yes | University Staff Member | 1 | StaffID | University Staff Member\_Research Area | 0..\* |
| works in2 |  | Research Area | 1 | FORCode | University Staff Member\_Research Area | 0..\* |

This did not result in the modification of any other relations with all other relations remain as per the previous sections.

#### University Staff Member oversees Research Area

This relationship allows a staff member to manage applications in a particular research area for all those in that research area not just their own associated applications.

Introduce the following relation:

|  |
| --- |
| **University Staff Member\_Research Area2** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |

Introduce the following relationships:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| Oversees | Yes | University Staff Member | 1 | StaffID | University Staff Member\_Research Area2 | 0..\* |
| Oversees2 | Yes | Research Area | 1 | FORCode | University Staff Member\_Research Area2 | 0..\* |

This did not result in the modification of any other relations with all other relations remain as per the previous sections.

#### Application in Research Area

Introduce the following relation:

|  |
| --- |
| **Application\_Research Area** (ApplicationID, FORCode)  **Primary key** ApplicationID, FORCode  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** FORCode **references** Research Area(FORCode) |

Introduce the following relationships:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| in |  | Application | 1 | ApplicationID | Application\_Research Area | 1..\* |
| in2 |  | Research Area | 1 | FORCode | Application\_Research Area | 0..\* |

This did not result in the modification of any other relations with all other relations remain as per the previous sections.

#### University Staff Member flags Application

Introduce the following relation:

|  |
| --- |
| **University Staff Member\_Application** (StaffID, ApplicationID)  **Primary key** StaffID, ApplicationID  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |

Introduce the following relationships:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| flags | Yes | University Staff Member | 1 | StaffID | University Staff Member\_Application | 0..\* |
| flags2 | Yes | Application | 1 | ApplicationID | University Staff Member\_Application | 0..\* |

This did not result in the modification of any other relations with all other relations remain as per the previous sections.

### Complex relationship types

None in this case

### Multi-valued attributes

None in this case

### Document relations and foreign key attributes

Thus the full relations for this section in alphabetical order are

|  |
| --- |
| **Applicant** (ApplicantID, FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, AddressCountryISOCode, Mobile, Phone, Email, NationalityCountryISOCode, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID, ManagedByStaffID)  **Primary key** ApplicantID  **Alternate key** (FName, LName, DOB, StreetAddress, Suburb, Postcode, City, State, Country)  **Alternate key** (FName, LName, DOB, Email)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID) |
| **Application** (ApplicationID, applicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, awardType, flindersCampus, fullTime, paymentMethod)  **Primary key** ApplicationID  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** ManagedByStaffID **references** University Staff Member(StaffID) |
| **Application\_Research Area** (ApplicationID, FORCode)  **Primary key** ApplicationID, FORCode  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Correspondence** (CorrID, Date, Summary, Message, ApplicantID, StaffID, CorrMeth, toStaff  **Primary key** CorrID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** CorrMethod **references** Correspondence Method(Method) |
| **Decision** (DecID, Date, Comment, ApplicationID, StaffID, decType)  **Primary key** DecID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** DecTypeID **references** Decision Type(type) |
| **Decision Type** (type)  **Primary key** type |
| **Degree** (DegID, ApplicantID, Name, Type, YearCompleted, GPA, InstitutionName, InstitutionCountryISOCode)  **Primary key** DegID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Document** (DocID, UploadLink, Title, Description, DocType, DocStat, ApplicantID, ApplicationID)  **Primary key** UploadLink  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Publication** (PubID, ApplicantID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language)  **Primary key** PubID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Referee** (RefID, ApplicationID, Name, Relation, Phone, Email, AcademicLink, EnglishSpeaker, EnglishLiterate)  **Primary key** RefID  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Research Area** (FORCode, Description, ResearchArea, GeneralArea)  **Primary key** FORCode |
| **Supervise as** (StaffID, ApplicationID, PrimarySupervisor)  **Primary key** StaffID, ApplicationID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** University Staff Member(StaffID) |
| **University Staff Member** (StaffID, FName, LName, canSupervise)  **Primary key** StaffID |
| **University Staff Member\_Application** (StaffID, ApplicationID)  **Primary key** StaffID, ApplicationID  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **University Staff Member\_Research Area** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **University Staff Member\_Research Area2** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Visa** (VisaID, ApplicantID, OriginCountryISOCode, VISAStatus, ValidFrom, ValidTo)  **Primary key** VisaID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |

## Normalisation

For the following tables IDs have been added for consistency with subsequent documents, in some cases this introduced full dependencies if there is a already a candidate key , however these have been ignored when defining normalisation.

|  |  |  |
| --- | --- | --- |
| **Relation** | **Functional Dependencies** | **Remarks** |
| Applicant | ApplicantID → FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, Country, Mobile, Phone, Email, Nationality, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID  FName, LName, DOB, StreetAddress, Suburb, Postcode, City, State, Country → ApplicantID, PrefTitle, Mobile, Phone, Email, Nationality, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID  FName, LName, DOB, Email → ApplicantID, PrefTitle, StreetAddress, Suburb, Postcode, City, State, Country Mobile, Phone, Nationality, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Application | ApplicationID → ApplicantID, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposalDocID, AwardType, ManagedByStaffID, ProposedStartDate, ProposedSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, PayDocID, PaymentMethod, ApplicationStatus, flindersCampus, fullTime | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Correspondence | CorrID → Date, Summary, Message, ApplicationID, StaffID, CorrMethID, toStaff | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Decision | DecID → Date, Comment, ApplicationID, StaffID | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Degree | DegID →ApplicantID, Name, Type, YearCompleted, GPA, InstitutionName, InstituitonCountry  ApplicantID, Name → DegID, Type, YearCompleted, GPA, InstitutionName, InstituitonCountry | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Document\* | DocID → UploadLink, DocStatus, DocumentType, Title, Description, ApplicantID, ApplicationID  UploadLink → DocID, DocStatus, DocumentType, Title, Description, ApplicantID, ApplicationID | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Publication | PubID → ApplicantID, DocID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language | Attributes Publication, IssueNo, IssueDate, OnlineLink and OtherAuthorsNames are optional, therefore should not be considered as candidate keys.  No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Referee | RefID → ApplicationID, Name, Relation, Phone, Email, Profession, AcademicLink, EnglishSpeaker, EnglishLiterate | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| ResearchArea | FORCode → Description, ResearchArea, GeneralArea\* | No repeating groups.  has partial dependencies. (but is ignored due to increased complexity, otherwise would introduce a new GeneralArea relation)  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 2NF |
| University Staff Member | StaffID → LName, FName, canSupervise | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |
| Visa | VisaID → ApplicantID, VisaStatus, OriginCountry, ValidFrom, ValidTo | No repeating groups.  No partial dependencies.  No transitive dependencies.  Primary key fully determines non-primary-key attributes  ⇒ in 3NF |

The Relations introduced in section 1.8 to remove many-many relationships are all in 3NF or greater from as they include only two foreign keys which are not repeating groups, partially dependant on each other transiently dependant on each other.

### Lookup relations[[1]](#footnote-1)

In this schema there are several attributes with domains that allow only a small set of possible values. These attributes are Applicant(Nationality), Applicant(Country), Application(ApplicationStatus), Application(PaymentMethod), Document(DocumentStatus), Document(DocumentType), Visa(VisaStatus), Decision(DecisionType), Correspondence(CorrespondencMethod), and Award(AwardType).

In order to reduce the chance of update anomalies from keying-in incorrect values, we choose to create a lookup relation for each of these. In all cases, these relations are in one-to-many relationships with the relations containing their corresponding attributes. So, in each case, the lookup relation is designated the parent relation, the other relation is designated the child, and the primary key of the lookup table is posted to the child relation in place of the attribute.

This approach also has the benefit that users can: alter the associated description/types easily; or extend these domains to cover new cases as they arise.

|  |
| --- |
| **ApplicationStatus** (Status, Description)  **Primary key** Status |
| **Decision Type** (Type)  **Primary key** Type |
| **CorrespondenceMethod** (method)  **Primary key** Method |
| **AwardType** (Type, Description, Method)  **Primary key** Type |
| **Payment Method** (Method)  **Primary key** Method |
| **DocumentStatus** (Status, Description)  **Primary key** Status |
| **DocumentType** (Type, Description)  **Primary key** Type |
| **Visa Status** (Status, Description)  **Primary key** Status |
| **Country** (CountryISOCode, Name)  **Primary key** CountryISOCode |

ALL these lookup relations have no repeated groups, partial dependencies or repeated groups and are thus in at least 3NF. It is also recognised that their introduction will introduce more joins in standard use but it is expected that this will make the management of applications and applicants more efficient, also maintaining the data integrity.

These were the added into their corresponding child relations (highlighted in blue in section 2.2)

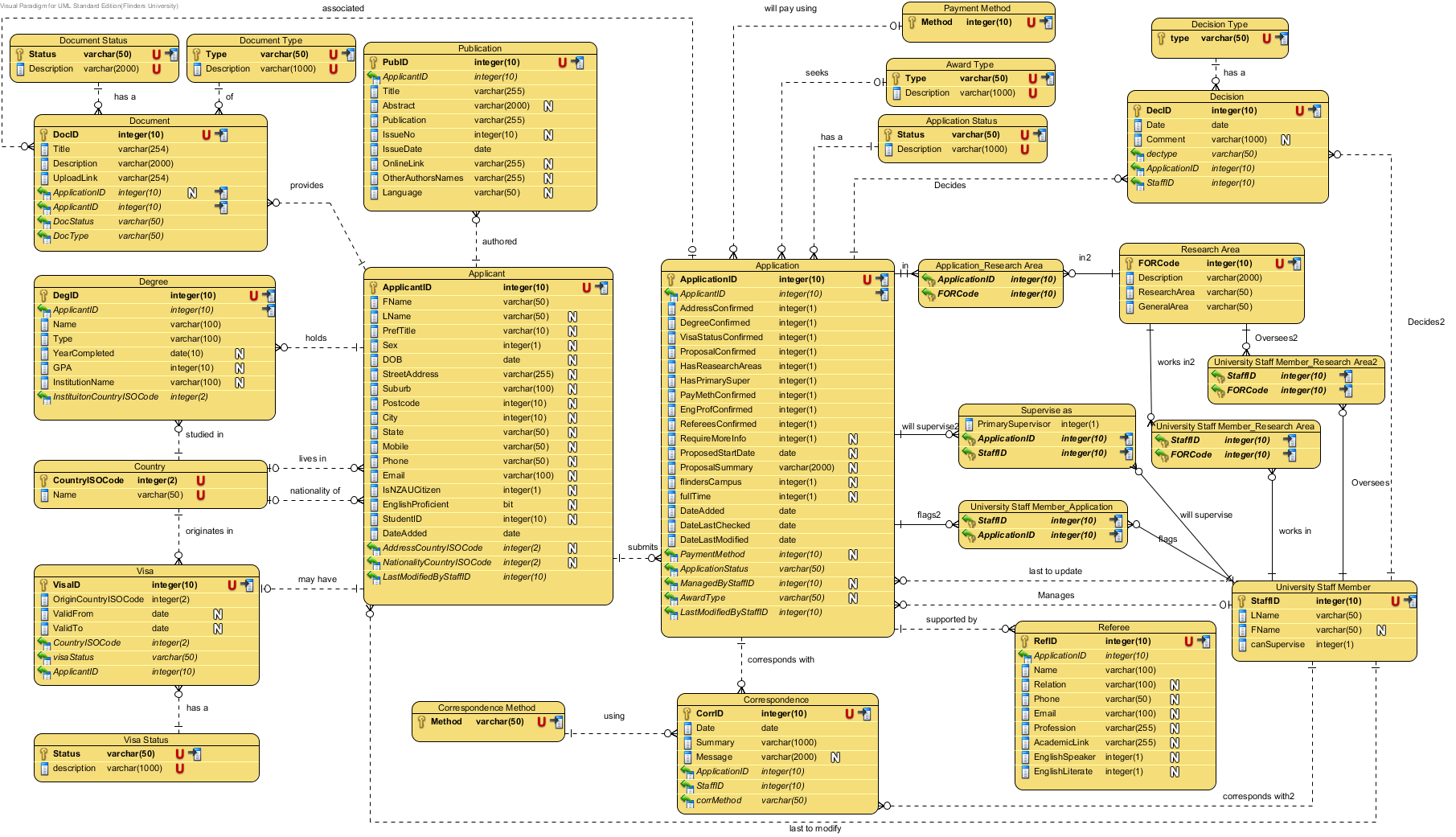
#### Lookup relationships[[2]](#footnote-2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Relationship name** | **Identifying** | **Parent relation** | **Parent multiplicity** | **Foreign Keys** | **Child relation** | **Child multiplicity** |
| lives in | No | Country | 1..1 | CountryISOCode→ AddressCountryISOCode | Applicant | 0..\* |
| nationality of | No | Country | 0..1 | CountryISOCode→ NationalityCountryISOCode | Applicant | 0..\* |
| has a | No | Visa Status | 1..1 | VisaStatus | Visa | 0..\* |
| originates in | No | Country | 1..1 | CountryISOCode → OriginCountryISOCode | Visa | 0..\* |
| has a | No | Document Status | 1..1 | Status → DocStat | Document | 0..\* |
| of | No | Document Type | 1..1 | Type → DocType | Document | 0..\* |
| will pay using | No | Payment Method | 0..1 | Method →paymentMethod | Application | 0..\* |
| has a | No | Application Status | 1..1 | Status → applicationStatus | Application | 0..\* |
| has a | No | Decision Type | 1..1 | type → decType | Decision | 0..\* |

### Normalised Relations

|  |
| --- |
| **Applicant** (ApplicantID, FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, AddressCountryISOCode, Mobile, Phone, Email, NationalityCountryISOCode, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID)  **Primary key** ApplicantID  **Alternate key** (FName, LName, DOB, StreetAddress, Suburb, Postcode, City, State, Country)  **Alternate key** (FName, LName, DOB, Email)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** AddressCountryISOCode **references** Country(CountryISOCode)  **Foreign key** NationalityCountryISOCode **references** Country(CountryISOCode) |
| **Application** (ApplicationID, applicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, AwardType, flindersCampus, FullTime, PaymentMethod, ManagedByStaffID)  **Primary key** ApplicationID  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** ManagedByStaffID **references** University Staff Member(StaffID)  **Foreign key** awardType **references** AwardType(Type)  **Foreign key** applicationStatus **references** Application Status(Status)  **Foreign key** paymentMethod **references** Payment Method(Method) |
| **Application\_Research Area** (ApplicationID, FORCode)  **Primary key** ApplicationID, FORCode  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Application Status** (Status, Description)  **Primary key** Status |
| **AwardType** (Type, Description, Method)  **Primary key** Type |
| **Correspondence** (CorrID, Date, Summary, Message, ApplicantID, StaffID, CorrMeth, toStaff  **Primary key** CorrID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** CorrMethod **references** Correspondence Method(Method) |
| **Correspondence Method** (Method)  **Primary key** Method |
| **Country** (CountryISOCode, Name)  **Primary key** CountryISOCode |
| **Decision** (DecID, Date, Comment, ApplicationID, StaffID, decType)  **Primary key** DecID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** DecTypeID **references** Decision Type(type) |
| **Decision Type** (type)  **Primary key** type |
| **Degree** (DegID, ApplicantID, Name, Type, YearCompleted, GPA, InstitutionName, InstitutionCountryISOCode)  **Primary key** DegID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** InstituitonCountryISOCode **references** Country(CountryISOCode) |
| **Document** (DocID, UploadLink, Title, Description, DocType, DocStat, ApplicantID, ApplicationID)  **Primary key** UploadLink  **Foreign key** DocType **references** DocumentType(Type)  **Foreign key** DocStat **references** DocumentStatus(Status)  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **DocumentStatus** (Status, Description)  **Primary key** Status |
| **DocumentType** (Type, Description)  **Primary key** Type |
| **Payment Method** (Method)  **Primary key** Method |
| **Publication** (PubID, ApplicantID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language)  **Primary key** PubID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Referee** (RefID, ApplicationID, Name, Relation, Phone, Email, AcademicLink, EnglishSpeaker, EnglishLiterate)  **Primary key** RefID  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Research Area** (FORCode, Description, ResearchArea, GeneralArea)  **Primary key** FORCode |
| **Supervise as** (StaffID, ApplicationID, PrimarySupervisor)  **Primary key** StaffID, ApplicationID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** University Staff Member(StaffID) |
| **University Staff Member** (StaffID, FName, LName, canSupervise)  **Primary key** StaffID |
| **University Staff Member\_Application** (StaffID, ApplicationID)  **Primary key** StaffID, ApplicationID  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **University Staff Member\_Research Area** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **University Staff Member\_Research Area2** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Visa** (VisaID, ApplicantID, OriginCountryISOCode, VisaStatus, ValidFrom, ValidTo)  **Primary key** VisaID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** VisaStatus **references** Visa Status(Status)  **Foreign key** OriginCountryISOCode **references** Country(CountryISOCode) |
| **Visa Status** (Status, Description)  **Primary key** Status |
| **Applicant** (ApplicantID, FName, LName, PrefTitle, Sex, DOB, StreetAddress, Suburb, Postcode, City, State, AddressCountryISOCode, Mobile, Phone, Email, NationalityCountryISOCode, isNZAUCitizen, EnglishProficient, StudentID, DateAdded, LastToModifyStaffID)  **Primary key** ApplicantID  **Alternate key** (FName, LName, DOB, StreetAddress, Suburb, Postcode, City, State, Country)  **Alternate key** (FName, LName, DOB, Email)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** AddressCountryISOCode **references** Country(CountryISOCode)  **Foreign key** NationalityCountryISOCode **references** Country(CountryISOCode) |
| **Application** (ApplicationID, applicationStatus, AddressConfirmed, DegreeConfirmed, VisaStatusConfirmed, ProposalConfirmed, HasResearchAreas, HasPrimarySuper, PayMethConfirmed, EngProfConfirmed, RefereesConfirmed, LastToModifyStaffID, ProposedStartDate, ProposalSummary, RequireMoreInfo, DateAdded, DateLastChecked, DateLastModified, awardType, flindersCampus, fullTime, paymentMethod)  **Primary key** ApplicationID  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** LastToModifyStaffID **references** University Staff Member(StaffID)  **Foreign key** ManagedByStaffID **references** University Staff Member(StaffID)  **Foreign key** awardType **references** AwardType(Type)  **Foreign key** applicationStatus **references** Application Status(Status)  **Foreign key** paymentMethod **references** Payment Method(Method) |
| **Application\_Research Area** (ApplicationID, FORCode)  **Primary key** ApplicationID, FORCode  **Foreign key** ApplicantID **references** Application(ApplicationID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Application Status** (Status, Description)  **Primary key** Status |
| **AwardType** (Type, Description, Method)  **Primary key** Type |
| **Correspondence** (CorrID, Date, Summary, Message, ApplicantID, StaffID, CorrMeth, toStaff  **Primary key** CorrID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** CorrMethod **references** Correspondence Method(Method) |
| **Correspondence Method** (Method)  **Primary key** Method |
| **Country** (CountryISOCode, Name)  **Primary key** CountryISOCode |
| **Decision** (DecID, Date, Comment, ApplicationID, StaffID, decType)  **Primary key** DecID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** UniversityStaffMember(StaffID)  **Foreign key** DecTypeID **references** Decision Type(type) |
| **Decision Type** (type)  **Primary key** type |
| **Degree** (DegID, ApplicantID, Name, Type, YearCompleted, GPA, InstitutionName, InstitutionCountryISOCode)  **Primary key** DegID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** InstituitonCountryISOCode **references** Country(CountryISOCode) |
| **Document** (DocID, UploadLink, Title, Description, DocType, DocStat, ApplicantID, ApplicationID)  **Primary key** UploadLink  **Foreign key** DocType **references** DocumentType(Type)  **Foreign key** DocStat **references** DocumentStatus(Status)  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **DocumentStatus** (Status, Description)  **Primary key** Status |
| **DocumentType** (Type, Description)  **Primary key** Type |
| **Payment Method** (Method)  **Primary key** Method |
| **Publication** (PubID, ApplicantID, Title, Publication, IssueNo, IssueDate, OnlineLink, OtherAuthorsNames, Language)  **Primary key** PubID  **Foreign key** ApplicantID **references** Applicant(ApplicantID) |
| **Referee** (RefID, ApplicationID, Name, Relation, Phone, Email, AcademicLink, EnglishSpeaker, EnglishLiterate)  **Primary key** RefID  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **Research Area** (FORCode, Description, ResearchArea, GeneralArea)  **Primary key** FORCode |
| **Supervise as** (StaffID, ApplicationID, PrimarySupervisor)  **Primary key** StaffID, ApplicationID  **Foreign key** ApplicationID **references** Application(ApplicationID)  **Foreign key** StaffID **references** University Staff Member(StaffID) |
| **University Staff Member** (StaffID, FName, LName, canSupervise)  **Primary key** StaffID |
| **University Staff Member\_Application** (StaffID, ApplicationID)  **Primary key** StaffID, ApplicationID  **Foreign key** StaffID **references** University Staff Member(StaffID)  **Foreign key** ApplicationID **references** Application(ApplicationID) |
| **University Staff Member\_Research Area** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **University Staff Member\_Research Area2** (StaffID, FORCode)  **Primary key** StaffID, FORCode  **Foreign key** StaffID **references** University Staff Member (StaffID)  **Foreign key** FORCode **references** Research Area(FORCode) |
| **Visa** (VisaID, ApplicantID, OriginCountryISOCode, VisaStatus, ValidFrom, ValidTo)  **Primary key** VisaID  **Foreign key** ApplicantID **references** Applicant(ApplicantID)  **Foreign key** VisaStatus **references** Visa Status(Status)  **Foreign key** OriginCountryISOCode **references** Country(CountryISOCode) |
| **Visa Status** (Status, Description)  **Primary key** Status |

### Logical E-R Diagram



## User transaction validation

University Staff Members

|  |  |
| --- | --- |
| # | pathway |
|  | Look up applicant + publications + degrees + visa Status + Associated documents by applicant name |
|  | Look up applicant’s applications by applicant name |
|  | Look up applicant’s applications by applicant email |
|  | Look up incomplete applications |
|  | Look up all correspondences relevant to an application |
|  | Create new applicant and associated application records |
|  | Look up which staff member updated an Application most recently |
|  | Check for any decision recorded about an application |
|  | Look up an existing application and attach a new standard type document to an application |
|  | Look up an existing application and attached a new exceptional type document to an application |
|  | Look up an existing application and list outstanding information (checklist). |
|  | Update the checklist to confirm that a mandatory information requirement has been met |
|  | Retrieve all on-going applications for which the user has made the most recent correspondence |
|  | Record making a decision about an application |
|  | Update the status of an application |

Academic Staff

|  |  |
| --- | --- |
| # | pathway |
|  | Look up, add to, and delete from own current research areas |
|  | Search for all applications in certain research areas that have been added since a certain time |
|  | Flag interest in an application |

RHD Co-ordination Staff

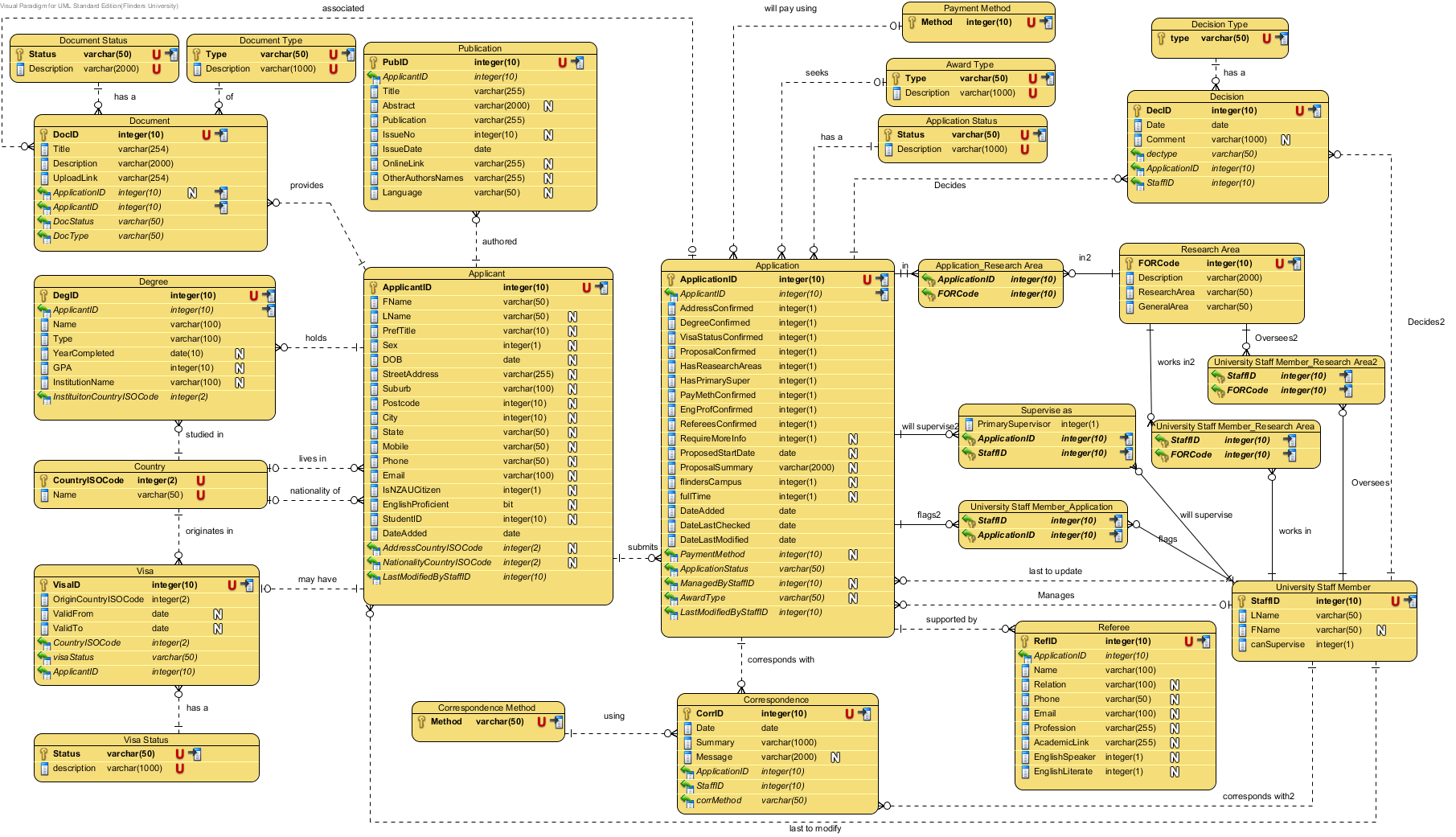
|  |  |
| --- | --- |
| # | pathway |
|  | Retrieve all staff who have flagged an application, or have edited an application or applicant record most recently |
|  | Retrieve all ongoing applications |

Note that the following modelling changes were triggered when validating user transactions:

* (e) – we had Correspondence in relationship with Applicant, but that could not record which correspondence was in regard to which application. We changed this to have Correspondence in relationship Application.

It should also be noted that the lookup relations will help facilitate in user transactions as entered data will be in a more consistent state i.e. document types will have set names rather than having to enter a new name in each time braking the integrity of the database.

### Transaction pathways



a1

a2

a3

a4

a5, i, j

b, c,

f, i

e, m

r

s

g, s

r

s

p

p

q

q

h, n

d, t, o

k, l, o

## Check integrity constraints

The following type of integrity constraints have been added to the logical model to protect the database from becoming incomplete, inaccurate, or inconsistent.

### Required data

Required data has been specified through the use of not-null attributes identified in section 3 of the conceptual Documentation. These have been reviewed and included in the logical diagram. Since attributes in VP-UML are null-able by default, the following attributes were changed to not null, that is are required:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Applicant** | | **Degree** | | **ResearchArea** | |
| fName | 1.1 | name | 4.1 | FORCode | 9.1 |
| sex | 1.4 | type | 4.2 | Description | 9.2 |
| email | 1.15 | **Document** | | researchArea | 9.3 |
| dateAdded | 1.20 | Title | 5.1 | generalArea | 9.4 |
| **Application** | | uploadLink | 5.3 | **University Staff Member** | |
| dateAdded | 2.3 | documentType | 5.4 | staffID | 12.1 |
| dateLastChecked | 2.4 | documentStatus | 5.5 | lName | 12.3 |
| dateLastModified | 2.5 | **Publication** | | **Visa** | |
| awardType | 2.7 | title | 7.1 | VisaStatus | 13.3 |
| **Checklist** | | Publication | 7.3 | **Correspondence** | |
| applicationStatus | 3.1 | issueDate | 7.5 | date | 14.1 |
| addressConfirmed | 3.2 | **Referee** | | Summary/message | 14.2 |
| degreeConfirmed | 3.3 | name | 8.1 | corrMeth | 14.4 |
| visaConfirmed | 3.4 | relation | 8.2 | toStaff | 14.5 |
| proposalConfirmed | 3.5 | email | 8.4 | **Decision** | |
| engProfConfirmed | 3.6 | Profession | 8.5 | date | 15.1 |
| hasResearchAreas | 3.7 |  |  | decType | 15.2 |
| hasPrimarySuper | 3.8 |  |  | **SuperviseAs** | |
| payMethConfirmed | 3.9 |  |  | primarySupervisor | 16.1 |
| refereesConfirmed | 3.10 |  |  |  |  |

All other attributes not mentioned here are required to maintain integrity.

Note that some of these attributes are moved to separate entities in the next section, in these cases the foreign key will be not null. Furthermore any attributes added to one of these entities will also be not null and unique.

### Attribute domain constraints

The attribute domains identified in section 4 of the conceptual documentation, have been introduced in the form of lookup relations, as produced in sections 2.2 and 2.3, and have been added to the logical diagram.

### Multiplicity

The multiplicities identified in section 2 of the conceptual documentation and above in sections 1.3-17, have been added to the diagram. The additional multiplicities for the lookup tables identified in sections 2.2 and 2.3 have also been added to the logical diagram.

### Entity integrity

The primary keys identified in section 5 of the conceptual documentation, have been reviewed in section 1 and added to/updated in the diagram. The additional primary keys for the attribute domain entities identified in section 4.2 have also been identified in section 1 and added to the diagram.

### Referential integrity

The primary key of each parent relation has been added to the child relation in the form of a foreign key as specified by the Strong and weak entity table in sections 1.1, 1.2 and 1.7.

#### Null attributes (~insert rules)

It should be noted however that the attribute domain relations Identified in section 4.1 that replace null-able attributes will add their primary key as a null-able foreign keys in the child relation. More specifically Award Type, Country, Payment Method and Study Load and Location can all be null in the applicant/applicant entities because they may not be known at the time of the initial input of the entry.

#### Updates & Deletes

It is expected that there will be a significant amount of updates as an application (and applicant) progresses through the process. As such all entities have been set to cascade upon any update of the parent table. Even though it is expected that deletions will be rare (if at all) functionality has been included to maintain the integrity of the database. Deletions are performed such that

* All weak entities, that are children of applicant and or application only, CASCADE on delete excluding document which requires applicant to be deleted and
* All lookup tables and University Staff member relationships RESTRICT on all deletes.

This will enable all application/applicant specific material to be removed upon the deletion of an applicant and all application material removed upon a delete. Correspondingly the removal of statuses and other lookup tables (or staff tables) will not leave any of its children such as document without a status. This is particularly relevant for application status as the deletion of a status, will make it lose its point in the process.

RESTRICT has been chosen as it reflects the requirement that nothing should be deleted, since it is possible that mistakes and repeated data can be entered some deletion is enable in this way.

### General constraints.

Currently there are no high level constraints that will affect the validity of the logical model. If any are later realised that will be discovered during Review or the final checks of the physical diagram.

There are however pseudo constraints through the checklist (now merged into the application) whereby an application cannot have certain application statuses unless the corresponding checklist attributes are true.

### Document all integrity constraints

All integrity constraints have been applied to the logical model, which can be used to produce a data dictionary when required.

## Review logical data model

The Logical data model will be reviewed with Paul, the head of the Research Higher Degree Office to ensure that it meets all their requirements and is a true (or as close to possible) representation of the data requirements as specified by the Research Higher Degree Office and the staff members who will use the database.

Some of the areas of specific mention that we have included in the data base are

* The use of lookup tables for better data consistency and integrity
* A flat more variable document relation enabling documents of specific types to be added and not necessarily linked to a specific relation of an applicant.
* Nearly all of the database relations are in 3NF with some divergences such as the above added to increase efficiency

## Check for future growth

It has been found that there are several possible areas that the logical database model may need to include in future. These include but are not limited to

* Expanding research areas, within the school of CSEM or the wider university,
* The possible inclusion of a housing & transport weak entity/attribute for the application/applicant,
* The inclusion of some form of disability/issues entity and or
* The addition of other statuses, types or other lookup tuples.

It has been found that these areas can be accounted for, in the form of adding new entities or attributes. However some possible future growths areas such as the reuse of referees for anther applications (by the same applicant) will break the model and force a redesign. Even though the redesign will be minor, creating a RefereeApplicaiton entity of referee and application IDs and replacing applicationID with applicantID (if maintaining connection with the applicant), it will mean the database and any programs will have to go offline while the modifications are made.

It has been assumed that such cases occur rarely and as such re-entering details will not be too inefficient. This will ensure that any detail changes that occur between applications are added as different entries.

## Develop Test Plan

### Introduction

**General description:** The database will from the back bone of the application storage for prospective Research Higher Degree (RHD) students. The database will allow academic staff, research higher degree staff and database administrator’s access to create, update and mange RHD applications.

**Mission statement:** To produce a database that can be used to manage the initial applications of prospective Research Higher Degree Students

**Schedule**

To write the database Definition

To find data and write scripts to populate the database

To write scripts that mimic possible transactions

To then run the scripts automatically to ensure transactions are possible and operate as desired

Iteratively add more data, possible transaction scripts and continue testing until all of the core transactions are covered and the majority of the infrequent transactions have some level of minimum coverage

### Required resources

|  |  |  |
| --- | --- | --- |
| **Type** | **What** | **Why** |
| Software | MySQL Community Edition | The DBMS platform the DB will run on |
| Text Editor | To write and edit scripts |
| Hardware | Two computers | To run MySQL and the text editor |
| Testing Tools | STKUnit | To automate testing of the scripts |
| Staff | 2 people | To both write and check the scripts |

### Testable aspects

**Unit tested transactions**

* All the user transactions, pathways mentioned above in section 3.3 on page 57.

### Non Testable aspects

* Any graphical user interface that uses these the database will not be tested
* Highly specific performance enhancements
* Maintenance transactions (Deletions, though the required functionality has been implemented)

### Test Produced documents

A single test document, listing

* The specifics of each test, what they are trying to test
* Assumptions
* Demonstration that the test pass

### Risks and dependencies

* It is not possible to test the database as it will be in a few yeas time and the issues it may have, due to the impracticality of populating the database with such a large volume of information.
* It is not possible to test all transaction pathways as many are complicated and will be used rarely if at all

### Project Criteria

Goal: To ensure that the database can handle the main transactions as outlined in previous document in line with the overall requirements of the database.

### Success and Failure measured by

Success will be measured based on the amount of tests that pass combined with their relevance to the core transactions of the database

## CHANGE LOG

1. Added intermediate relationships, corrected some difference between how terms are stated here and subsequent documents increasing consistency.
2. Added notes about normalising many-many introduced relations and lookup relations

1. applied methodology as described in ‘Chapter 18 Methodology – Monitoring and Tuning the Operational System Step 7.2 Duplicating non-key attributes in one-to-many (1:\*) relationships to reduce joins’ [↑](#footnote-ref-1)
2. applied methodology as described in ‘Chapter 18 Methodology – Monitoring and Tuning the Operational System Step 7.2 Duplicating non-key attributes in one-to-many (1:\*) relationships to reduce joins’ [↑](#footnote-ref-2)