

RequirementsManager

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Abstract

ReM¹ is an administrative software that makes you minimize time and maximize result in the *Software Engineering* process of collecting and creating requirements.

¹*ReM*, Requirements Manager.

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Analysis

It's requested to realize a database that allows a team to optimize Software's Analysis by managing Requirements creation. Each one of them descends from a Request that could be created by a team member or by the project customers.

Preliminary

Interview

The aim is to manage requirements during all phases of software production and revision storing away all final and in production data relative to releases already published or yet to publish. Everything has to start from a *Request*. Once it has been created the relative *Requirement/s* can be developed.

The system admin has to create users and the relative database linked to a software. Requests can be created by a team member or a customer. Requirements can be developed by team members only. Requests and therefore Requirements can obviously be added or even edited in later releases. It's not important to keep track of every update or change, the important is to keep track of final data just before a release. The timeline can be added by a team member only and domain conditions has to be respected.

Requirements have to be structured with a title, a type (functional, non functional), a version, a description, a body, one or more files, progress data, a creation time and a last modified time. Moreover for a requirement it has to be known the user that did the first and last modifies and an history of updates with times and users that did them. Furthermore is important to consider that requirements could be arranged in a tree structure in the most complex cases.

Requests structure consists of a title, a type, a version, a description, a body, one or more files, a creation time and a last modified time. Besides for a request it has to be known the user that did the first and last modifies and an history of updates with times and users that did them.

A requirement has to be associated with one and only one request, a request can be associated with multiple requirements.

A request has to be approved by a team member before developing it into a requirement. After the approval a customer has to accept the request approval, only then the relative requirement can be developed. When the approval is done the request mustn't be able to be modified.

Users has to be saved with personal info such as username, name, surname, email, phone and optionally the company name.

The releases should also save a short description and a name that has to be an identifier between the timelines. It's important to permit the creation of a new timeline only if every requirement was completed, or this mustn't be permitted. In addition every request has to be approved, formalized into requirement and completed before the version creation.

Every data that was affected by the version cannot be overridden so their last modified time should be previous to the version creation time.

Glossary

A glossary of terms with description, synonyms and links used in Interview is here explained in Table 1.

| Term | Description | Synonyms | Links |
|-------------|--|-------------------|----------------------|
| Request | Customer request of what the system should do | | Requirement, release |
| Requirement | Formal description of what the system should do | | Request, release |
| | Requirements + Requests | Data | |
| Editor | User that can add Requirements | Team member | |
| Guest | User that can only add Requests | Customer | |
| User | Editor + Guest | User | Editing, versioning |
| Release | A timeline that confirms the fact that a software version was released | Version, timeline | Data |

Table 1: Glossary of terms

Requirements

This section aims to restructure requirements according to the Preliminary phase.

Functional

- General
 - It is demanded to realize a database that manages requirements;
 - Information that have to be stored are **Requests**, **Requirements**, **Users** and **Releases**;
- Users
 - **Users** are structured with username, name, surname, email, phone and optionally the company name;

- **Users** are divided into two groups:
 - * **Editors** - they approve *Requests*, develop relative *Requirements* and decides *Releases*; in some cases they could also create *Requests*;
 - * **Guests** - they create *Requests* that once approved cannot be edited but will be developed into *Requirements*;
- Requests
 - **Requests** are structured with a title, a type, a version (positive integer), a description, a body, one or more files, a creation time and a last modified time;
- Requirements
 - **Requirements** are structured with a title, a type (functional, non functional), a version (positive integer), a description, a body, one or more files, progress data (a percentage), a creation time and a last modified time;
 - **Requirements** could be arranged in a tree structure;
- Releases
 - **Releases** are structured with a unique name (software version name), a short description and the creation time;
 - **Releases** are timelines that can be created only if all *Requests* had been approved and converted into already fully developed *Requirements*;
- Conditions
 - all **Requests** and **Requirements** relative to a **Release** have to be historicized;
 - **Requests** and **Requirements** could be modified or even invalidated in later **Releases**;
 - a **Requirement** has to be associated with one and only one **Request**, a **Request** can be associated with multiple **Requirements**.

Non-Functional

- Data access has to be really fast;
- CRUD² operations should be non blocking in final GUI³;

²*CRUD*, Create, read, update, delete.

³*GUI*, Graphical user interface.

Actions

The mainly requested actions are:

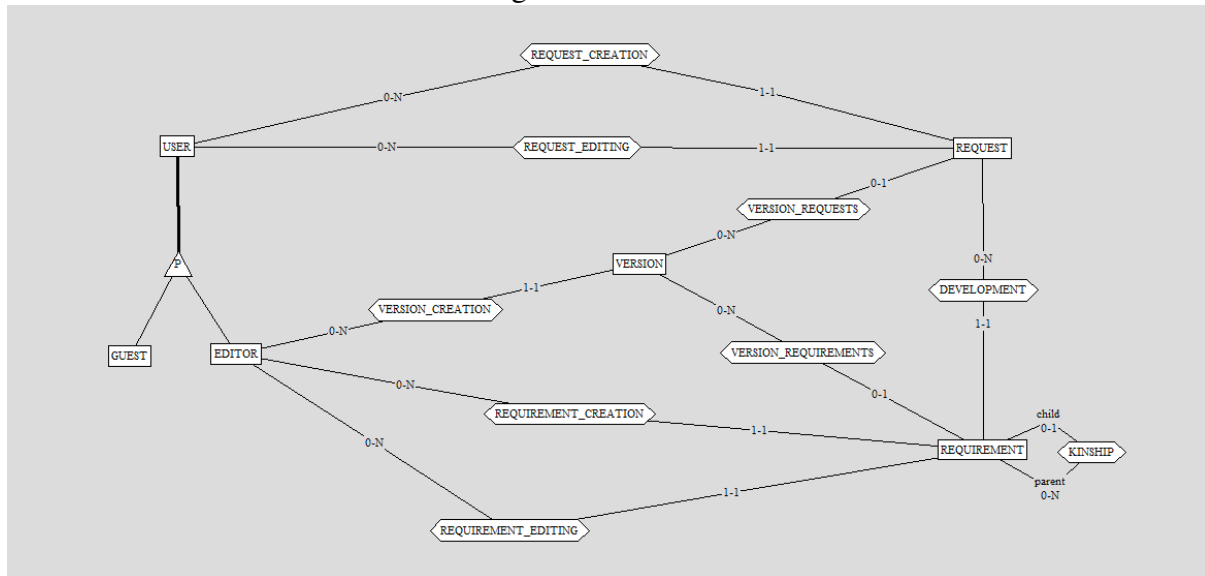
1. Subscribe a new user;
2. View a request;
3. Create a request;
4. Update a request;
5. Approve a request;
6. View a requirement;
7. Create a requirement;
8. Update a requirement;
9. Disable a requirement;
10. Create a release;
11. Show requirements and requests relative to a specific release;
12. View single requirement history (every change for each release);
13. Obtain an average of the progress time relative to a branch of the requirements tree;

Conceptual design

In production I chose to use a mixed strategy to build the E/R diagram.

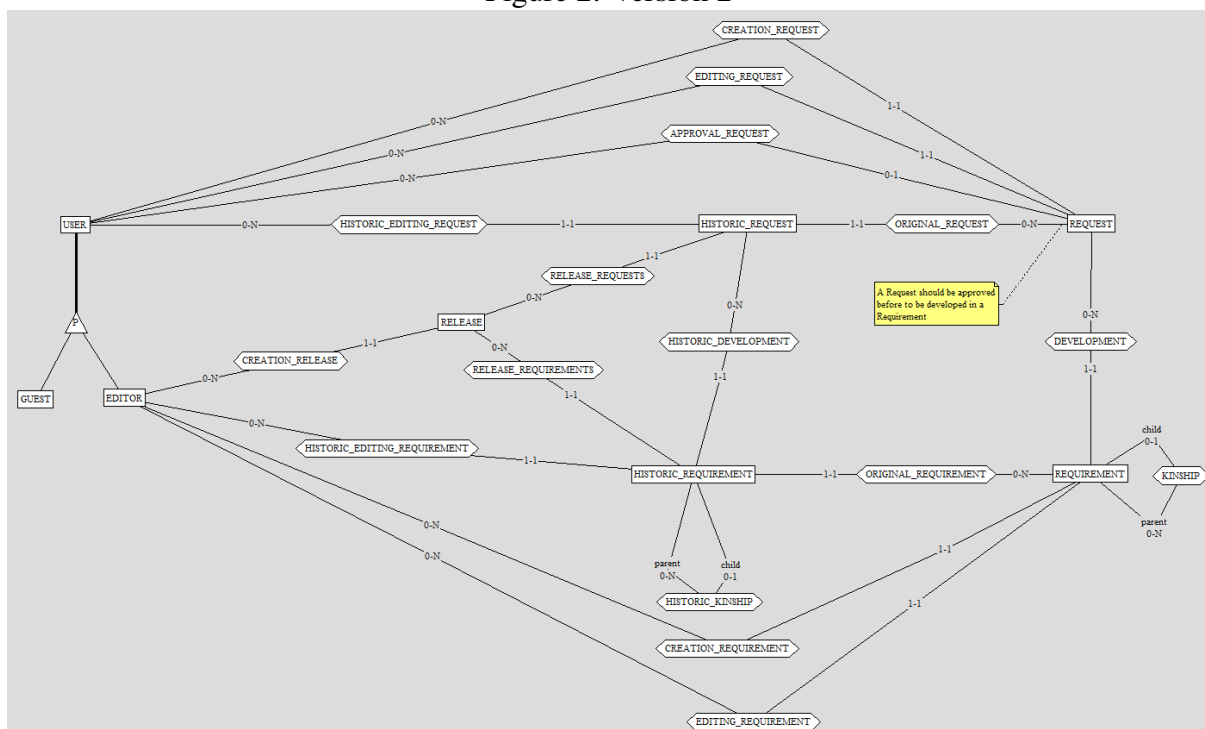
A first version of the E/R diagram explained in figure 1. This diagram represents the skeleton of the E/R diagram. Here I made the "mistake" of mixing time concepts with static ones. In fact Requests and Requirements are single entity sets but their historic of a Version (Release) is not well managed.

Figure 1: Version 1



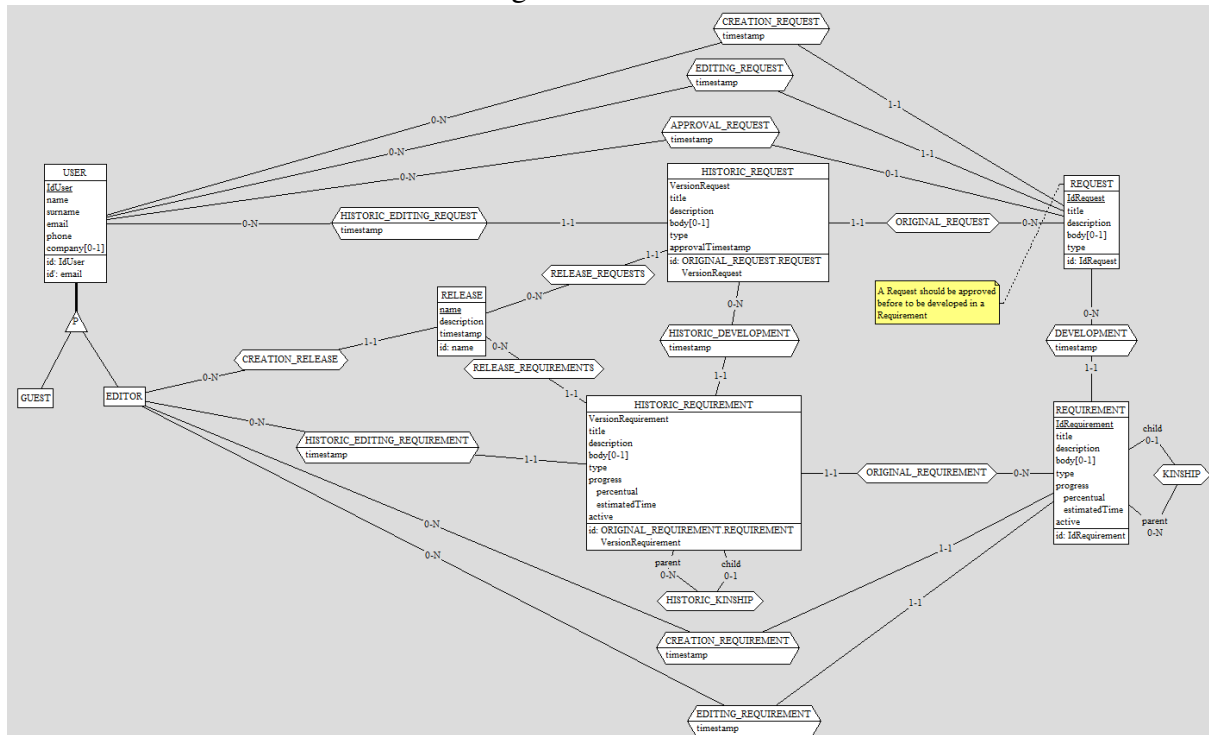
A second version of the E/R diagram explained in figure 2. Here a clean schema shows how Requests and Requirements should be traced in their historic versions. Furthermore is important to watch that an historic version is always created when a new Release is published, independently from Requests or Requirements changes. This could lead to an inefficient use of storage...

Figure 2: Version 2



A third version of the E/R diagram explained in figure 3. Here every attribute is present and shows which data are stored for each entity/relationship.

Figure 3: Version 3



Logical design

Table of volumes

Data and expected volumes are described in Table 2.

| Concept | Construct | Volume |
|------------------------------|-----------|--------|
| USER | E | 100 |
| GUEST | E | 90 |
| EDITOR | E | 10 |
| REQUEST | E | 50 |
| HISTORIC_REQUEST | E | 40 |
| REQUIREMENT | E | 75 |
| HISTORIC_REQUIREMENT | E | 50 |
| RELEASE | E | 5 |
| DEVELOPMENT | R | 70 |
| HISTORIC_DEVELOPMENT | R | 50 |
| KINSHIP | R | 5 |
| HISTORIC_KINSHIP | R | 5 |
| CREATION_RELEASE | R | 5 |
| RELEASE_REQUESTS | R | 40 |
| RELEASE_REQUIREMENTS | R | 50 |
| CREATION_REQUEST | R | 50 |
| EDITING_REQUEST | R | 50 |
| HISTORIC_EDITING_REQUEST | R | 40 |
| APPROVAL_REQUEST | R | 45 |
| CREATION_REQUIREMENT | R | 70 |
| EDITING_REQUIREMENT | R | 70 |
| HISTORIC_EDITING_REQUIREMENT | R | 50 |
| ORIGINAL_REQUEST | R | 40 |
| ORIGINAL_REQUIREMENT | R | 50 |

Table 2: Volumes of data

Operations and frequency

Operations and frequency are described in Table 3.

| Code | Operation | Frequency |
|------|--|----------------|
| 1 | Subscribe a new user | 10 every month |
| 2 | View a request | 200 every day |
| 3 | Create a request | 2 every day |
| 4 | Update a request | 5 every day |
| 5 | Approve a request | 1 every day |
| 6 | View a requirement | 200 every day |
| 7 | Create a requirement | 2 every day |
| 8 | Update a requirement | 50 every day |
| 9 | Disable a requirement | 1 every month |
| 10 | View a release | 2 every day |
| 11 | Create a release | 2 every year |
| 12 | Show requirements and requests relative to a specific release | 50 every day |
| 13 | View single requirement history (every change for each release) | 10 every day |
| 14 | Obtain an average of the progress time relative to a branch of the requirements tree | 20 every day |

Table 3: Operations and frequency

Navigation and access

1. Subscribe a new user

User subscription described in Table 4.

| Concept | Construct | Access | Type |
|----------------------------|-----------|--------|------|
| User | E | 1 | W |
| Total: 1W → 10 every month | | | |

Table 4: Subscribe a new user

2. View a request

Request visualization described in Table 5.

| Concept | Construct | Access | Type |
|---------------------------|-----------|--------|------|
| Request | E | 1 | R |
| Total: 1R → 200 every day | | | |

Table 5: View a request

3. Create a request

Request creation described in Table 6.

| Concept | Construct | Access | Type |
|-------------------------------------|-----------|--------|------|
| Request | E | 1 | W |
| Total: 1W \rightarrow 2 every day | | | |

Table 6: Create a request

4. Update a request

Request updating described in Table 7.

| Concept | Construct | Access | Type |
|---|-----------|--------|------|
| Request | E | 1 | R |
| Request | E | 1 | W |
| Total: 1R + 1W \rightarrow 10 every day | | | |

Table 7: Update a request

5. Approve a request

Request approval described in Table 8.

| Concept | Construct | Access | Type |
|--|-----------|--------|------|
| Request | E | 1 | R |
| Request | E | 1 | W |
| Total: 1R + 1W \rightarrow 2 every day | | | |

Table 8: Approve a request

6. View a requirement

Requirement visualization described in Table 9.

| Concept | Construct | Access | Type |
|---------------------------------------|-----------|--------|------|
| Requirement | E | 1 | R |
| Total: 1R \rightarrow 200 every day | | | |

Table 9: View a requirement

7. Create a requirement

Requirement creation described in Table 10.

| Concept | Construct | Access | Type |
|-------------------------------------|-----------|--------|------|
| Requirement | E | 1 | W |
| Total: $1W \rightarrow 2$ every day | | | |

Table 10: Create a requirement

8. Update a requirement

Requirement updating described in Table 11.

| Concept | Construct | Access | Type |
|--|-----------|--------|------|
| Requirement | E | 1 | R |
| Requirement | E | 1 | W |
| Total: $1R + 1W \rightarrow 100$ every day | | | |

Table 11: Update a requirement

9. Disable a requirement

Requirement disabling described in Table 12.

| Concept | Construct | Access | Type |
|--|-----------|--------|------|
| Requirement | E | 1 | R |
| Requirement | E | 1 | W |
| Total: $1R + 1W \rightarrow 2$ every month | | | |

Table 12: Disable a requirement

10. View a release

Release visualization described in Table 13.

| Concept | Construct | Access | Type |
|-------------------------------------|-----------|--------|------|
| Release | E | 1 | R |
| Total: $1R \rightarrow 2$ every day | | | |

Table 13: View a release

11. Create a release

Release creation described in Table 14.

| Concept | Construct | Access | Type |
|--------------------------------------|-----------|--------|------|
| Release | E | 1 | W |
| Total: $1W \rightarrow 2$ every year | | | |

Table 14: Create a release

12. Show requirements and requests relative to a specific release

Requests and requirements visualization described in Table 15.

| Concept | Construct | Access | Type |
|-----------------------------|-----------|-------------|------|
| Release | E | 1 | R |
| Release_requests | E | 8 (40 / 5) | R |
| Requests | E | 8 | R |
| Release_requirements | E | 10 (50 / 5) | R |
| Requirements | E | 10 | R |
| Total: 37R → 1850 every day | | | |

Table 15: Show requirements and requests relative to a specific release

13. View single requirement history

Requests and requirements visualization described in Table 16.

| Concept | Construct | Access | Type |
|----------------------------|-----------|---------------|------|
| Requirement | E | 1 | R |
| Original_requirement | E | 0.7 (50 / 75) | R |
| Historic_requirement | E | 0.7 | R |
| Total: 2.4R → 24 every day | | | |

Table 16: View single requirement history

14. Obtain an average of the progress time relative to a branch of the requirements tree

Requests and requirements visualization described in Table 17.

| Concept | Construct | Access | Type |
|-------------------------------|-----------|---------------|------|
| Requirement | E | 1 | R |
| Kinship | E | 0.07 (5 / 75) | R |
| Historic_requirement | E | 0.07 | R |
| Total: 1.14R → 22.8 every day | | | |

Table 17: Obtain an average of the progress time relative to a branch of the requirements tree

Redundancy analysis

10. View a release

Release visualization without redundancy described in Table 18.

| Concept | Construct | Access | Type |
|---------------------------|-----------|-------------|------|
| Release | E | 1 | R |
| Release_requests | E | 8 (40 / 5) | R |
| Release_requirements | E | 10 (50 / 5) | R |
| Total: 19R → 38 every day | | | |

Table 18: View a request without redundancy

Restructured diagram

Hierarchy elimination

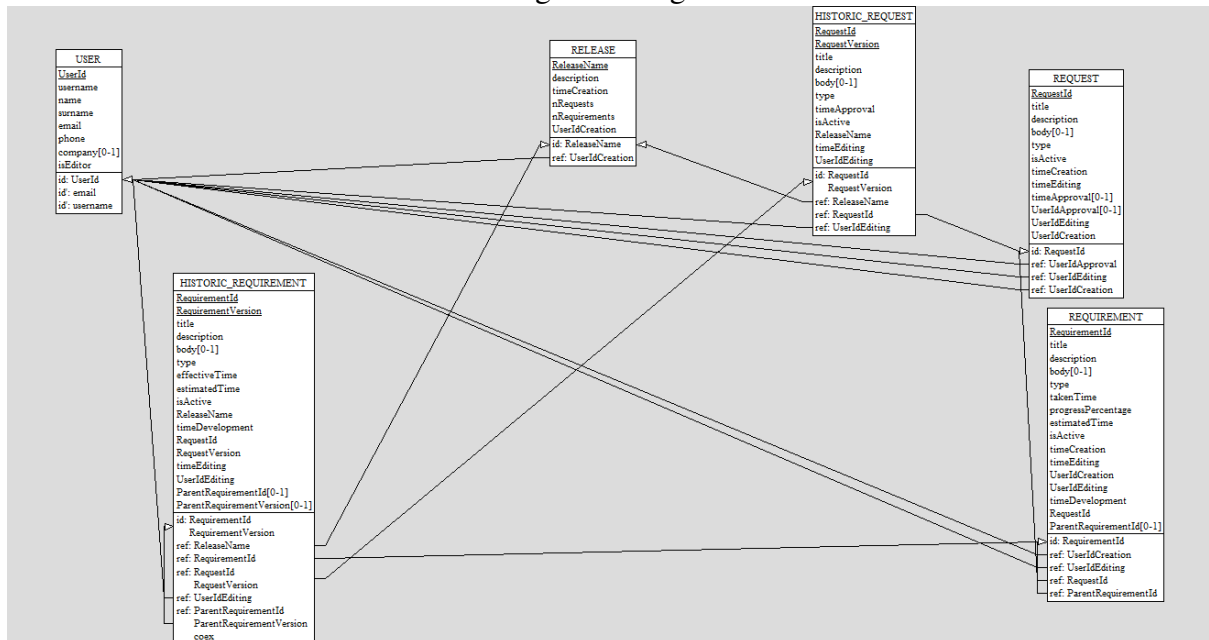
It was chosen the collapse to the top for the necessity to have a unique identifier for the users (this helps in references). The distinction between Guest and Editor users is given to a flag that indicates if a user is also an Editor.

Associations many-to-many

In this case it was chosen to translate them by putting an external identifier in the 1-1 relationship to refer to the other entity.

The E/R diagram restructured is explained in figure 4.

Figure 4: Logic



Entity and relationships translation in relations

USERS(UserId, username, name, surname, email, phone, company*, isEditor)

NOTES:

Unique(username)
Unique(email)

RELEASES(ReleaseId, name, description, timeCreation, nRequests, nRequirements, UserId-
Creation: *USERS*)

NOTES:

Unique(name)

REQUESTS(RequestId, title, description, body*, type, isActive, UserIdCreation: *USERS*,
timeCreation, UserIdEditing: *USERS*, timeEditing, UserIdApproval*: *USERS*, timeApproval*)

NOTES:

A constraint should make 'UserIdApproval' and 'timeApproval' to be both present or absent at the same time.

REQUIREMENTS(RequirementId, title, description, body*, type, isActive, UserIdCreation: *USERS*, timeCreation, UserIdEditing: *USERS*, timeEditing, progressPercentage, estimatedHours, takenHours, RequestId: *REQUESTS*, ParentRequirementId*: *REQUIREMENTS*)

HISTORIC_REQUESTS(RequestId: *REQUESTS*, RequestVersion, title, description, body*, type, isActive, UserIdEditing: *USERS*, timeEditing, timeApproval, ReleaseId: *RELEASES*)

HISTORIC_REQUIREMENTS(RequirementId: *REQUIREMENTS*, RequirementVersion, title, description, body*, type, isActive, UserIdEditing: *USERS*, timeEditing, estimatedHours, takenHours, (RequestId, RequestVersion): *HISTORIC_REQUESTS*, (ParentRequirementId, ParentRequirementVersion)*: *HISTORIC_REQUIREMENTS*, ReleaseId: *RELEASES*)

MySQL queries

In this section the previously described operations are translated into MySQL queries.

Subscribe a new user operation query described in Listing 1.

```
1  -- UserId was set as AUTO_INCREMENT, so it can be omitted here
2  INSERT INTO `USERS`
3      ('username', 'name', 'surname',
4       'email', 'phone', 'company',
5       'isEditor')
6  VALUES
7      (?, ?, ?, ?, ?, ?, ?);
```

Listing 1: op. 1

View a request operation query described in Listing 2.

```
1  SELECT *
2  FROM `REQUESTS`
3  WHERE 'RequestId' = ?;
```

Listing 2: op. 2

Create a request operation query described in Listing 3.


```

1  INSERT INTO 'REQUESTS'
2      ('title', 'description', 'type',
3       'isActive', 'UserIdCreation',
4       'UserIdEditing', 'timeEditing')
5  VALUES
6      (?, ?, ?, ?, ?, ?, NOW());

```

Listing 3: op. 3

Update a request operation query described in Listing 4.

```

1  UPDATE 'REQUESTS'
2  SET 'title' = ?,
3      'description' = ?,
4      'body' = ?,
5      'type' = ?,
6      'isActive' = ?,
7      'UserIdEditing' = ?,
8      'timeEditing' = NOW()
9  WHERE 'RequestId' = ?;

```

Listing 4: op. 4

Approve a request operation query described in Listing 5.

```

1  UPDATE 'REQUESTS'
2  SET 'UserIdApproval' = ?,
3      'timeApproval' = NOW(),
4      'UserIdEditing' = ?,
5      'timeEditing' = NOW()
6  WHERE 'RequestId' = ?;

```

Listing 5: op. 5

View a requirement operation query described in Listing 6.

```

1  SELECT *
2  FROM 'REQUIREMENTS'
3  WHERE 'RequirementId' = ?;

```

Listing 6: op. 6

Create a requirement operation query described in Listing 8.

```

1  INSERT INTO 'REQUIREMENTS'
2      ('title', 'description', 'type',
3       'isActive', 'UserIdCreation',
4       'UserIdEditing', 'timeEditing'
5       'RequestId', 'ParentRequirementId')
6  VALUES
7      (?, ?, ?, ?, ?, ?, NOW(), ?, ?);

```

Listing 7: op. 7

Update a requirement operation query described in Listing 8.

```

1  UPDATE 'REQUIREMENTS'
2  SET 'title' = ?,
3      'description' = ?,
4      'body' = ?,
5      'type' = ?,
6      'isActive' = ?,
7      'UserIdEditing' = ?,
8      'timeEditing' = NOW(),
9      'progressPercentage' = ?,
10     'estimatedHours' = ?,
11     'takenHours' = ?
12 WHERE 'RequestId' = ?;

```

Listing 8: op. 8

Disable a requirement operation query described in Listing 9.

```

1  UPDATE 'REQUIREMENTS'
2  SET 'isActive' = ?,
3      'UserIdEditing' = ?,
4      'timeEditing' = NOW(),
5  WHERE 'RequestId' = ?;

```

Listing 9: op. 9

View a release operation query described in Listing 10.

```

1  SELECT *
2  FROM 'RELEASES'
3  WHERE 'ReleaseId' = ?;

```

Listing 10: op. 10

Create a release operation query described in Listing 11.

```

1  INSERT INTO 'RELEASES'
2      ('name', 'description', 'UserIdCreation')
3  VALUES
4      (?, ?, ?);

```

Listing 11: op. 11

Show requirements and requests relative to a specific release operation query described in Listing 12.

```

1  SELECT
2      h_requests.*,
3      h_requirements.*
4  FROM
5      'RELEASES' releases,
6      'HISTORIC_REQUESTS' h_requests,
7      'HISTORIC_REQUIREMENTS' h_requirements
8  WHERE
9      releases.'ReleaseId' = h_requests.'ReleaseId' AND

```

```

10     releases.'ReleaseId' = h_requirements.'ReleaseId';
11 -- is equivalent to
12 SELECT
13     h_requests.*,
14     h_requirements.*
15 FROM
16     'RELEASES' releases,
17 INNER JOIN 'HISTORIC_REQUESTS' h_requests
18     ON requests.'ReleaseId' = releases.'ReleaseId'
19 INNER JOIN 'HISTORIC_REQUIREMENTS' h_requirements
20     ON h_requirements.'ReleaseId' = h_requirements.'ReleaseId';

```

Listing 12: op. 12

View single requirement history operation query described in Listing 13.

```

1 SELECT
2     h_requirements.*
3 FROM
4     'REQUIREMENTS' requirements,
5     'HISTORIC_REQUIREMENTS' h_requirements
6 WHERE
7     requirements.'RequirementId' = h_requirements.'RequirementId'

```

Listing 13: op. 13

Obtain an average of the progress time relative to a branch of the requirements tree operation query described in Listing 14.

```

1 -- Common Table Expressions are supported from MySQL 8
2 WITH RECURSIVE 'RequirementTree' AS (
3     -- Anchor member: Select the starting node (i.e. the root of the
4     -- branch)
5     SELECT *
6     FROM 'REQUIREMENTS'
7     WHERE 'RequirementId' = ? -- Replace ? with the ID of the root
8     requirement
9     UNION ALL
10    -- Recursive member: Select all children of the current level
11    SELECT r.*
12    FROM 'REQUIREMENTS' r
13    INNER JOIN 'RequirementTree' rt ON r.'ParentRequirementId' = rt.'
14    RequirementId'
15 )
16 -- Final selection: Sum up the values from the CTE
17 SELECT
18     SUM('progressPercentage') AS 'totalProgressPercentage',
19     SUM('estimatedHours') AS 'totalEstimatedTime',
20     SUM('takenHours') AS 'totalTakenTime'
21 FROM 'RequirementTree';

```

Listing 14: op. 14

Application

General

It was chosen a C# .NET Core 8.0 application running on Windows with Windows Forms GUI. As anticipated with the queries the database is MySQL.

Following this report philosophy it was adopted a database first approach. So at first the Analysis was written, with: requirements, conceptual and logical design, and then the implementation started. A file named 'ReM.sql' was used as a script, partially derived from design and partially handwritten, to create schema (database) and tables in MySQL. It includes features to avoid illegal situations using checks and triggers, except for historic data that should be modified only behind the scenes in a real application.

So as to map data from MySQL to .NET Core 8.0 it was chosen to use Entity Framework Core. In particular with the process of 'Scaffolding' ⁴ it was possible to map directly the 'ReM' schema from MySQL to .NET Core 8.0 classes.

⁴<https://dev.mysql.com/doc/connector-net/en/connector-net-entityframework-core-scaffold-example.html>