SOFTWARE ENGINEERING

Hostel Allotment

Build a mobile application for the Hostel Allotment problem:
1. Problem overview
2. User stories (for the student app)
3. Mindmap
4. UI design (wire frames showing the sequence of steps)
5. Suggests for implementation

PROBLEM OVERVIEW

The Hostel Allotment Project is an attempt to streamline and automate the process of room assignment for college students. Hostel Allotment is an event that takes place every year and involves a very large number of students. It is an important part of the students' college stay since it decides the group of people that they will be interacting with on an almost daily basis. As such, this project aims to help the students to ensure that they are satisfied with their choice of wing, wingmates and room and will be comfortable spending their next few years there.

As a mobile application, the project will enable students to interact with it at any place and at any time, thus adding an additional level of comfort.

The Hostel Allotment Process

The hostel allotment process is divided into three rounds and each round has three segments.

Definitions

Group Representative: A group representative is the leader of the group. He/she takes decisions on behalf of the group.
Group Member: A group member is simply a part of a group.
Group Size Requirement: The size of a wing is the number of students that the wing can accommodate. To be a valid group so as to be considered for allotment, the size of a group must match one of the available wing sizes. This is the group size requirement.
Freezing a group: Once a group is frozen no new members can join the group and no current member can leave the group.

Hostel Layout

Throughout the hostel allotment process, all the students are able to see layouts of all the hostels that are available to them. The layout of every hostel is divided into floors. Each floor has several wings. The availability and size of each wing (the number of students that it can accommodate) is visible.

Prerequisites

1. All students must register on the mobile application.

Round 1

Segment 1: Group Formation

1. Each student has the freedom to be either a group member or a group representative. This choice can be changed until the end of the first segment.
2. Group representatives can send membership requests to students who have chosen to be group members, but are not yet part of any group. The student joins the group as soon as the request is accepted.
3. Students who have chosen to be group members, but are not yet part of any group, can send membership requests to group representatives to be a member of their group. They become members of that group as soon as the request is accepted.
4. If the group size requirement is met, then the group representative can initiate a request to freeze the group. The group is frozen if all members accept the group representative's request. All the groups that satisfy the group size requirement, but are not yet frozen, will be automatically frozen at the end of segment 1.
5. Before a group is frozen, a group member can leave the group by sending a request to the group representative. If the request is accepted, the student is no longer a member of the group.

After the end of segment 1, those groups that do not satisfy the group size requirement (and hence, are not frozen) are not considered for subsequent segments of the current round. The members of these groups must participate in group formation in the next round.

Segment 2: Wing Preferences

1. Each group representative whose group has been frozen can submit up to 3 different wings that their group would like to occupy in order of preference. The size of every wing that is given as a preference must be equal to the size of the group.
2. After the deadline for segment 2, the following algorithm (Wing and Room Allotment) is executed.

Wing and Room Allotment Algorithm:

1. A random permutation of all the groups that have submitted a valid wing preference is created. For example, let the groups that have submitted a valid wing preference be - $g_1, g_2, g_3, \ldots, g_{20}$. Then a random permutation could be - $g_{16}, g_4, g_8, \ldots, g_{13}$.
2. Sequentially, the groups in the random permutation are assigned their highest available preference. If none of their preferences are available, then they are randomly assigned a wing of the correct size. If there is no unoccupied wing whose size matches the size of their group, they are not assigned a wing. Members of such groups must try again in the next round.
3. Now, the groups that have not submitted a valid wing preference are considered. A similar random permutation is created and they are randomly assigned a wing of the correct size. If there is no unoccupied wing whose size matches the size of their group, they are not assigned a wing. Members of such groups must try again in the next round..

4. The members of the groups that have been assigned a wing are randomly assigned a room within the wing.

Segment 3: Room and Wing Swap

1. All members (group members and group representatives) of a group which has been assigned a wing after segment 2 can submit requests to other students in the same wing to exchange rooms with them. If the request is accepted, their rooms are swapped.
2. A group representative can submit wing swap requests to other group representatives who have been assigned a wing in this round if they both have the same wing sizes. If the request is accepted, the wings are swapped.
3. A group cannot now make a request to swap their current wing with a wing that is unoccupied, regardless of whether the wing sizes are the same or not. This is because the group could easily have obtained that wing by giving it as their highest preference.

All the groups that have been assigned wings will not be considered for the second and third rounds.

Round 2:

All the students who have not been assigned a room in round 1 can participate in round 2. Participating students can choose whether they want to be group members or group representatives, irrespective of their choice in round 1.

All the steps of round 1 are repeated again.

Wing swapping in this round is allowed only amongst those groups that were assigned a wing in this round. Room swapping (within the same wing) in this round is allowed only amongst those students who were assigned a room in this round.

Round 3:

All the students who have not been assigned a room in round 2 can participate in round 3. Participating students can choose whether they want to be group members or group representatives, irrespective of their choice in round 2and round 1.

Group Formation (segment 1) and wing preferences (segment 2) of round 3 are the same as that of round 1. The Wing and Room Allotment Algorithm used for round three is different from that used in rounds 1 and 2 to ensure that all students are assigned a room.

Wing and Room Allotment Algorithm for round 3:

1. After the random permutation and wing allotment, some groups might still not have been assigned a wing. These students, along with those who have not yet been assigned a room (for any reason), are considered here.
2. All these students will now be randomly assigned wings and rooms out of those that are still unoccupied. After this, all students have been assigned rooms and wings.

3. Each wing assigned in this manner is considered a new group and a randomly selected student is assigned as the group representative while the rest are group members. After this step, every student is part of some group and every group has a group representative.

Segment 3: Wing and Room Swapping

1. All students, regardless of the round in which they were assigned a room, can issue room swap requests for rooms within their own wings.
2. All group representatives can send wing swap requests to all other group representatives, regardless of the round in which they were assigned a wing.

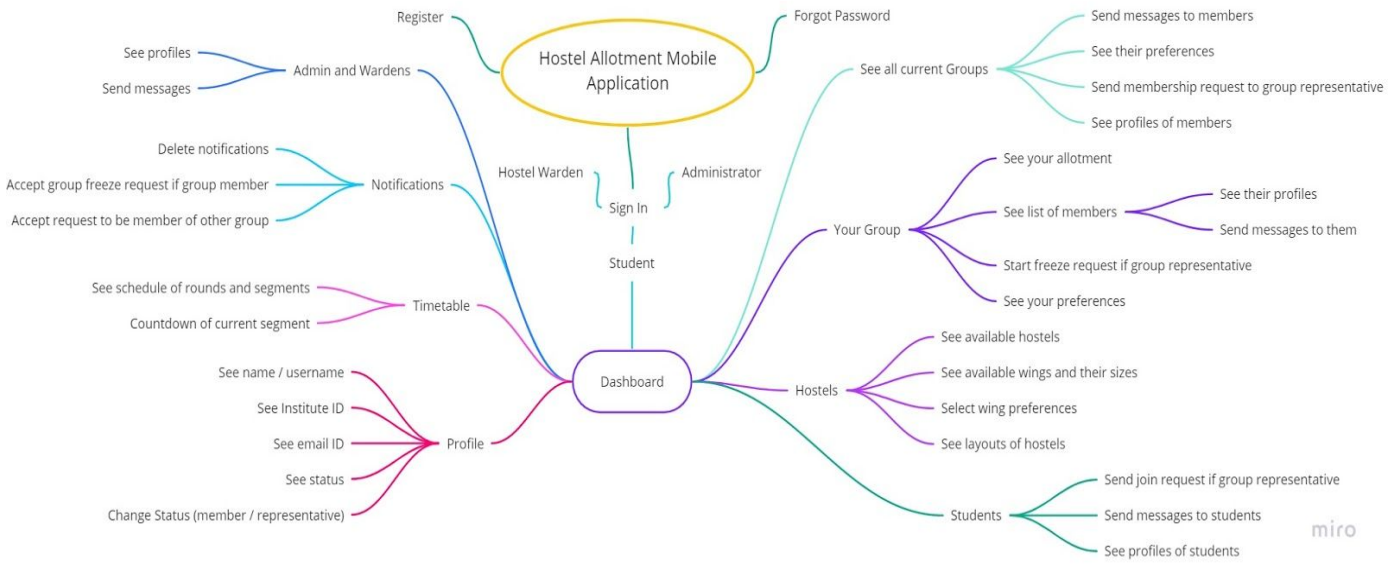
Apart from the students, the Hostel Wardens and the members of the administration also have access to the hostel allotment process.

Hostel Wardens: After each round the Hostel Warden can see which students have been assigned which rooms. They can send requests to the administration to reserve certain rooms/wings for various purposes.

Administrators: They can see the current state of the rounds (the groups that have been formed, the preferences of various groups, the rooms and wings that are occupied and empty) and also have the power to restrict certain rooms/wings from being available. This means that the selected room or wing will appear as unavailable to the students. In case there were already students occupying the wing/room, the assignment will be cancelled and they will once again be eligible for the next round. (In case this happens in the third round the students will randomly be assigned available rooms).

UI DESIGN (WIREFRAMES)

MIND MAP



Acceptance Criteria

Scenario:

Given

When

Then

USER STORIES

1. **As** a first time user
   I want to be able to register my account
   so that use the mobile application
   Acceptance Criteria
   Scenario: New user is able successfully register an account with the application.

   Given that I am a first time user
   When I open the application, there is an option to register my account.
   Then I can click the 'register' button, give my details, set up a password and register my account.
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2. **As** a registered user
   I want to be able to sign-in to my account
   so that use the mobile application
   Acceptance Criteria
   Scenario: Registered user is able successfully log into his/her account.

Given that I am a registered user who remembers his/her password
When I open the application, and fill in the correct details
Then I can click the ‘sign-in’ button, and I will be able to log into my account.

Given that I am a registered user who has forgotten his/her password
When I open the application there is an option for those who have forgotten their password
Then I can click the ‘forgot password’ button, and I will be directed to a page where I have to fill in my email and I will be able reset my password through the link there, and thus log into my account.

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3. **As** a student
   I want to be able to see which groups have which members
   so that I can decide which group I want to be in.
   Acceptance Criteria
   Scenario: Students can view members of all groups.

   Given that I am a registered user who has logged into his/her account
   When I open the application, and navigate to the ‘Groups’ section on the Dashboard
   Then I can click the respective group button and I will be able to see the names of all the students in that group.

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4. **As** a student
   I want to be able to see the wing preferences of all the groups
   so that I can contribute to the wing preferences of my group.
   Acceptance Criteria
   Scenario: Students can view wing preferences of all groups.

   Given that I am a registered user who has logged into his/her account
   When I open the application, and navigate to the ‘Groups’ section on the Dashboard
   Then I can click the respective group button and I will be able to see all the wing preferences for that group if the group has submitted any wing preferences.

   Given that I am a registered user who has logged into his/her account
   When I open the application, and navigate to the ‘Groups’ section on the Dashboard
   Then I can click the respective group button and if the group has not submitted any wing preferences, I will be able to see ‘No wing preferences’ under the preferences section for that group.

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5. **As** a student
   I want to be able to send messages to Admins and Wardens
   so that I can clarify any doubts that I might have.
   Acceptance Criteria

Scenario: Students can send messages to Admins and Wardens.

Given that I am a registered user who has logged into his/her account
When I open the application, and navigate to the ‘Users’ section on the Dashboard and then click the ‘Administrators’ or the ‘Hostel Wardens’ button
Then I can select the message icon beside the name of the admin or warden who I want to contact and send them a message.

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6. **As** a user
   I want to be able to see the schedule of rounds and segments
   so that I do not miss any deadlines.
   Acceptance Criteria
   Scenario: Users can see the schedule of rounds and segments.

   Given that I am registered user who has logged into his/her account
   When I open the mobile application and navigate to the ‘Schedule’ section on the dashboard
   Then I will be able to see the exact date and time for the start and end of each segment of each round.

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7. **As** a user
   I want to be able to see the details of how each segment and round is conducted
   so that I can better understand the hostel allotment process.
   Acceptance Criteria
   Scenario: Users can see details of rounds and segments.

   Given that I am registered user who has logged into his/her account
   When I open the mobile application and navigate to the ‘Schedule’ section on the dashboard
   Then by clicking on the information icon beside a given segment or round I will be able to see the details of how that round or segment is conducted.

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8. **As** a student
   I want to be able to see the layouts of the hostels and wings
   so that I can contribute to deciding the wing preferences of my group.
   Acceptance Criteria

   Scenario: Students can see the layouts of hostels and the sizes and arrangement of wings within the hostel.

   Given that I am registered user who has logged into his/her account

When I open up the application and navigate to the ‘Hostel Layout’ section on the Dashboard

Then I can see the various hostels which are available to me and if I click on the hostel, then I can see it's floor wise division and the locations and sizes of wings on those floors.

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9. **As** a group member
   I want to be able to send membership requests to group representatives
   so that I can become part of their groups.
   Acceptance Criteria
   Scenario: Group members can send membership requests to group representatives
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   Given that I am a registered user who has logged into his/her account and has chosen to be a group member
   When I open the application, and navigate to the ‘Groups’ section on the Dashboard
   Then I can click the respective group button and I will be able to send a message to the group representative by clicking on the message icon beside his name.
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10. **As** a group representative
    I want to be able to send membership requests to students
    so that they can become part of my group.
    Acceptance Criteria
    Scenario: Group representatives can send membership requests to group members
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    Given that I am a registered user who has logged into his/her account and has chosen to be a group representative
    When I open the application, and navigate to the ‘Students’ portal on the ‘Users’ section on the Dashboard
    Then I will be able to see a list of all the students colour coded to show whether they are already part of a group or not (whether as a group member or as a group representative) and can click the message icon beside their names to send a message to that student.
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11. **As** a group representative
    I want to be able to send a request to freeze my group
    so that I can restrict people from joining and leaving.
    Acceptance Criteria
    Scenario: Group representatives can send freeze requests to their own group members
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    Given that I am a registered user who has logged into his/her account and has chosen to be a group representative and my group satisfies the group size requirement
    When I open the application, and click on the ‘Your Group’ button on the Dashboard
    Then I will be able to click the ‘Send Freeze Request’ button and send out a freeze request to all members of my group.

Given that I am a registered user who has logged into his/her account and has chosen to be a group representative and my group does not satisfy the group size requirement
When I open the application, and click on the 'Your Group' button on the Dashboard and then click the 'Send Freeze Request' button
Then I will be shown a message saying, "Cannot send Freeze Request - Group Size Requirement not satisfied"

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12. **As** a student
    I want to be able to send messages to other students
    so that I can collaborate with them.
    Acceptance Criteria
    Scenario: Students can send messages to other students

    Given that I am a registered user who has logged into his/her account
    When I open the application, and navigate to the 'Students' portal on the 'Users' section on the Dashboard
    Then I will be able to see a list of all the students and can click the message icon beside their names to send a message to that student.

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13. **As** a student
    I want to be able to change my status from group member to group representative and vice versa
    so that I can adapt to the changing requirements of the group formation process.
    Acceptance Criteria
    Scenario: Student can change his/her status.

    Given that I am a registered user who has logged into his/her account and has not yet chosen whether I want to be a group member or a group representative
    When I open the application, and navigate to my profile by clicking the profile icon on the Dashboard
    Then I will be able to see an option to choose whether I want to be a group member or a group representative.

    Given that I am a registered user who has logged into his/her account and has already chosen whether I want to be a group member or a group representative
    When I open the application, and navigate to my profile by clicking the profile icon on the Dashboard
    Then I will be able to see an option to change my status. If I am a group member, clicking the button will change my status to group representative and if I am a group representative, clicking the button will change my status to group member.

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14. **As** a hostel warden or administrator

I want to be able to see the progress of the rounds
so that I can collaborate with other admins and wardens to quickly resolve any problems.
Acceptance Criteria
Scenario: Hostel Wardens and Admins can see progress of rounds
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Given that I am a registered warden or admin who has logged into his/her account
When I open the application, and navigate to the 'Progress' section on the Dashboard
Then I will be able to see the percentage of occupied wings, percentage of assigned groups, percentage of students without groups and other relevant data on the progress of the rounds and segments.
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15. **As** a hostel warden or admin
    I want to be able to send messages to students
    so that I can clarify their doubts or give them updates regarding any changes to the process.
    Acceptance Criteria
    Scenario: Wardens and Admins send messages to students

    Given that I am a registered admin or warden who has logged into his/her account
    When I open the application, and navigate to the 'Students' portal on the 'Users' section on the Dashboard
    Then I will be able to see a list of all the students and can click the message icon beside their names to send a message to that student or click the Announcement icon to send the same message to all users.
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16. **As** hostel wardens and administrators
    we want to be able to send messages to each other
    so that we can collaborate.
    Acceptance Criteria
    Scenario: Wardens and Admins send messages to each other

    Given that I am a registered admin or warden who has logged into his/her account
    When I open the application, and navigate to the 'Admin' or 'Hostel Warden' portals on the 'Users' section on the Dashboard
    Then I will be able to see a list of all the people in that category (Admin or Hostel Warden) and can click the message icon beside their names to send them a message.
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17. **As** an administrator
    I want to be able to restrict certain rooms or wings from being part of the hostel allotment process
    so that I can reserve them for other purposes like for guests and parents or for storage.

Acceptance Criteria

Scenario: Admins restrict a room or wing

Given that I am a registered admin who has logged into his/her account
When I open the application, navigate to the 'Hostel Layout' section on the Dashboard, and select the hostel, the floor and wing
Then I will be able to see a list of all the rooms in that wing, and I can click the minus icon beside the room to restrict it from being available for student occupancy.

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18. **As** a student
    I want to be able to see the status of my room allotment (whether I have been allotted a room and if yes, then the details of the room - Hostel name, floor number, wing number, room number)
    so that I know whether I need to participate in further rounds or not.
    Acceptance Criteria
    Scenario: Student check status of room allotment.

    Given that I am a registered student who has logged into his/her account and I have been allotted a room
    When I open the application, navigate to the 'Allotment' section on the Dashboard
    Then I will be able to see the details of the room that I have been alloted including hostel name, floor number, wing number and room number.

    Given that I am a registered student who has logged into his/her account and I have not been allotted a room
    When I open the application, navigate to the 'Allotment' section on the Dashboard
    Then the page will display a message saying, "Room not allotted yet".

IMPLEMENTATION SUGGESTIONS:

Goals of Hostel Allotment Mobile Application and methods to achieve them:

1. **Requirement**: The Hostel Allotment Application is going to be used by a large variety of users and, despite hostel allotment being a major part of a student's campus life, will be used only once. This means that the application must run smoothly, be highly intuitive to use and must have as small of a learning curve as possible.
   Strategy: There are three major possibilities for developing mobile applications - natively, as hybrid apps and web apps. Web apps have the disadvantage of poor performance and unreliable API's. Hybrid API's require large amounts of memory and also display performance issues. With native apps, the application can make use of the latest features, and have seamless performance. With high level languages like Kotlin and Swift the development is very easy. Also, since user reach is not a point of concern, native apps are the best strategy.
2. **Requirement**: The Hostel Allotment Application relies heavily on the messaging system between users - It uses it to form groups, to communicate and solve problems, to freeze

groups and to swap wings and rooms. This means that the architecture used must efficiently handle messages.

Strategy: One of the ways of handling extensive messaging reliance is to use an Event Driven Architecture (used by several messaging applications) combined with a Service Oriented Architecture (SOA). A service oriented architecture provides modular development, which enables several independent systems to interact efficiently with one another. This also enables faster development since it is possible to have multiple teams working on independent components. SOA also offers the flexibility of easy modification, if the hotel allotment algorithm is altered. This is why Event Driven SOA is an optimal implementation architecture.

3. **Requirement**: The Hostel Allotment application must store a large amount of (large number of students sending lots of messages), rapidly generated (heavy usage for short periods of time), frequently changing (room assignments change rapidly with swaps) messages and data. Additionally data integrity is also important.

   Strategy: There are 2 major types of Databases - SQL and NoSQL databases. Since the number of users is essentially fixed and it is important to ensure that room changes and assignments are executed correctly, SQL database, which easily maintains data integrity for fixed size databases and can implement rapid querying, is the right choice. However, since the messages are unstructured and will not be frequently queried, but can have large volume - a NoSQL database is the best choice. Thus a combination of SQL and NoSQL databases must be used to give optimal performance.