

**SWE 455 Software Maintenance and Evolution
Spring 2025**

Project Description – Deliverable 2 & 3

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Slicing

#	Slice criteria	Slice	Slicing type	Selection reason
1	<129, _accept>	Slice: [20, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 444, 445, 446, 447, 448, 449, 450, 451] Refer to Figure [1] , [2] , [3] , [4] & [5], Figure [6] for PDG.	Backward static slicing	Program Understanding (Unclear variable purpose): We analyzed whether _accept is actively contributing to logic or UI state. It turned out _accept was used to control the display of the “Add Friend” button.
2	<77, _createGoalAnd AddTask>	Slice: [77, 78, 79, ..., 263] Figure [7] , [8] , [9] & [10] Refer to Figure [13] for PDG.	Forward static slicing	Program Understanding (Unclear method name): Despite suggesting only task addition, this method also handles full goal creation, validation, notifications, and navigation. The current method name will decrease the code readability.
3	<152, combinedTaskStreams>	Slice: [134, 135, 136, 137, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152]	Backward Dynamic Slice	Debugging, to understand how the list of task streams is constructed and what contributes to it.
4	<78, isSharedGoal >	Slice: [78, 79, 81, 82, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108] Refer to Figure 11 for code.	Forward Dynamic Slice	Impact analysis, to see how the determination of whether a goal is shared affects subsequent code execution.

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Slice #1

```

15
16  class _SearchFriendsScreenState extends State<SearchFriendsScreen> {
17    final TextEditingController _searchController = TextEditingController(text: '5'); // Initialize with '5'
18    final GlobalKey<FormState> _formKey = GlobalKey<FormState>();
19    List<DocumentSnapshot> _searchResults = [];
20    var _accept = false;
21    final Map<String, bool> _requestStatuses = {};

```

Figure 1.11 the code before the slicing for slice #1

```

89
90  // Check if a friend request is already sent
91  Future<void> _checkFriendRequestStatus(String friendId) async {
92    String userId = FirebaseAuth.instance.currentUser!.uid;
93    DocumentSnapshot requestDoc = await FirebaseFirestore.instance
94      .collection('Users')
95      .doc(friendId)
96      .collection('friendRequests')
97      .doc(userId)
98      .get();
99
100   await FirebaseFirestore.instance
101     .collection('Users')
102     .doc(userId)
103     .collection('RequestsStatus')
104     .get()
105     .then((value) {
106       var exist = false;
107       var stat = "pendding";
108       for (var i in value.docs) {
109         if (i.data()["userId"] == friendId) {
110           exist = true;
111           stat = i.data()["Status"];
112         }
113       }
114       if (exist == true && stat == "accepted") {
115
116         setState(() {
117           _accept =
118             true;
119         });
120         print("ok"); // Don't invoke 'print' in production code. Try using a logging framework.
121       } else {
122
123         setState(() {
124           _requestStatuses[friendId] =
125             requestDoc.exists;
126         }); // Set status based on existence
127       }
128     });
129     print(_accept); // Don't invoke 'print' in production code. Try using a logging framework.
130   }

```

Figure 1.2 the code before the slicing for slice #1

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```

424             trailing: isCurrentUser
425             ? null
426             : isPendingRequest
427             ? IconButton(
428                 icon: Icon(Icons
429                     .access_time), // Clock icon for pending status // Icon
430                 color: Colors.grey,
431                 onPressed: () {
432                     _showDialog(
433                         'Friend request already sent');
434                 },
435             ) // IconButton
436             : _accept?null: IconButton(
437                 icon: Row(
438                     mainAxisAlignment: MainAxisAlignment.min,
439                     children: [
440                         Icon(Icons.person,
441                             color: Colors.white), // Icon
442                         Icon(Icons.add,
443                             color: Colors.white), // Icon
444                     ],
445                 ), // Row
446                 onPressed: () =>
447                     _sendFriendRequest(friend),
448             ), // IconButton
449         ). // ListTile

```

Figure 1.3 the code before the slicing for slice #1

```

class _SearchFriendsScreenState extends State<SearchFriendsScreen> {
  final TextEditingController _searchController = TextEditingController(text: '5'); // Initialize with '5'
  final GlobalKey<FormState> _formKey = GlobalKey<FormState>();
  List<DocumentSnapshot> _searchResults = [];
  var _accept = false;
  final Map<String, bool> requestStatuses = {};

```

Figure 2.2 the code after the slicing for slice #1

```

// Check if a friend request is already sent
Future<void> _checkFriendRequestStatus(String friendId) async {
  String userId = FirebaseAuth.instance.currentUser!.uid;
  DocumentSnapshot requestDoc = await FirebaseFirestore.instance
    .collection('Users')
    .doc(friendId)
    .collection('friendRequests')
    .doc(userId)
    .get();

  await FirebaseFirestore.instance
    .collection('Users')
    .doc(userId)
    .collection('RequestsStatus')
    .get()
    .then((value) {
  var exist = false;
  var stat = "pending";
  for (var i in value.docs) {
    if (i.data()["userId"] == friendId) {
      exist = true;
      stat = i.data()["Status"];
    }
  }
  if (exist == true && stat == "accepted") {
    setState(() {

```

Figure 2.3 the code after the slicing for slice #1

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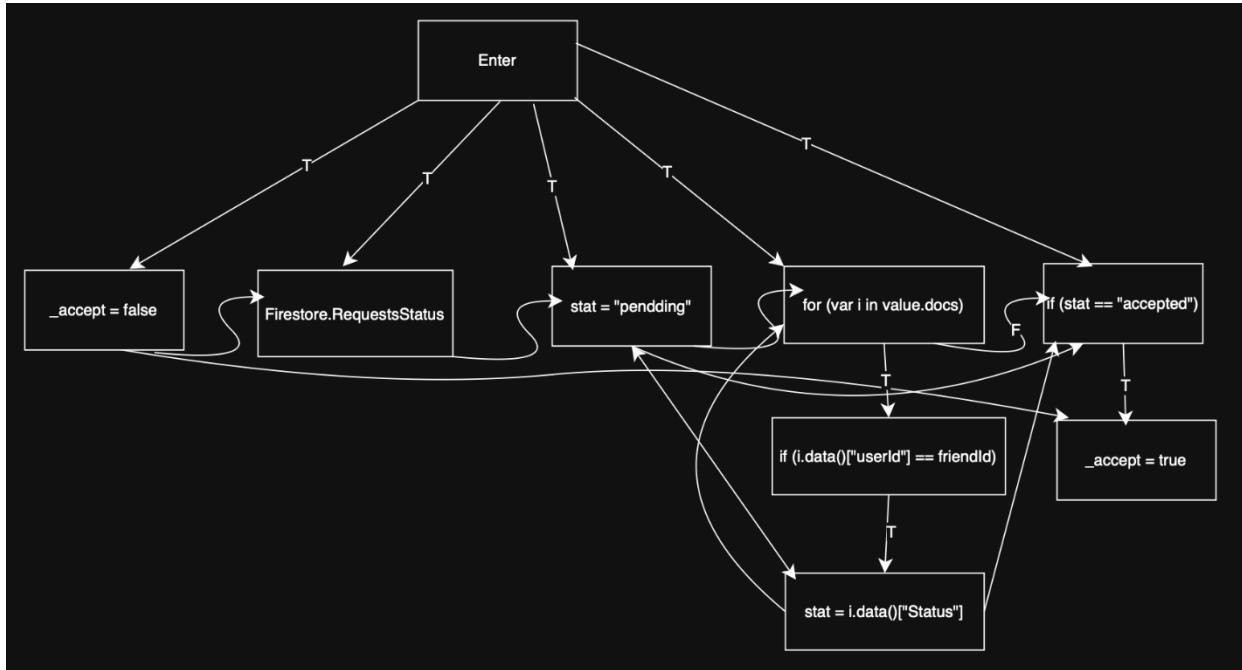


Figure 3 PDG for slice #

Slice #2

```
77 Future<void> _createGoalAndAddTask() async {
78   showLoadingDialog(context);
79   setState(() {
80     _isTaskNameValid = _taskNameController.text.isNotEmpty;
81     _isDateValid = _selectedDate != null;
82     _isStartTimeValid = _startTime != null;
83     _isEndTimeValid = _endTime != null &&
84       (_endTime!.hour > _startTime!.hour ||
85        (_endTime!.hour == _startTime!.hour &&
86         _endTime!.minute > _startTime!.minute));
87   });
88
89   if (!_validateInputs()) {
90     Navigator.of(context).pop();
91     return;
92   }
93
94   if (_isTaskNameValid ||
95     !_isDateValid ||
96     !_isStartTimeValid ||
97     !_isEndTimeValid) {
98     Navigator.of(context).pop(); //dismiss loading
99     ScaffoldMessenger.of(context).showSnackBar(
100       const SnackBar(content: Text('Please fill in all required fields')),
101     );
102   }
103   return;
104 }
105
106 try {
107   final User? user = FirebaseAuth.instance.currentUser;
108   if (user == null) throw Exception("User not logged in");
109
110   final String? userPhoneNumber = user.phoneNumber;
111   if (userPhoneNumber == null) {
112     throw Exception(
113       "Phone number is not available for the logged-in user.");
114   }
115
116   QuerySnapshot userSnapshot = await FirebaseFirestore.instance
117     .collection('Users')
118     .where('phoneNumber', isEqualTo: userPhoneNumber)
119     .limit(1)
120     .get();
121
122   DocumentReference userDocRef;
123   if (userSnapshot.docs.isEmpty) {
124     userDocRef =
125       await FirebaseFirestore.instance.collection('Users').add({
```

Figure 4.1 the code before the slicing for slice #2

Figure 4.2 the code before the slicing for slice #2

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```
174
175     startTime: _selectedDate, // Ensure _selectedDate is non-null
176     endTime: _endTime, // Ensure _endTime is non-null
177     location: _locationController.text,
178     locationId: _locationController.id,
179     recurrenceType: _selectedRecurrence ?? 'No recurrence', // Default to 'No recurrence'
180     description: _descriptionController.text.isNotEmpty
181         ? _descriptionController.text
182         : null,
183     taskName: _taskNameController.text,
184     goalsRef: _referenceGoalsCollectionRef,
185     goalsData: widget.goal,
186     isSharedGoal: widget.isSharedGoal,
187     sharedKey: widget.sharedID ?? '',
188
189     );
190
191     if (createdTasks.isNotEmpty) {
192         log("Recurring tasks created successfully!");
193         widget.isTaskCreated();
194         await FirebaseFirestore.instance
195             .collection("sharedGoal")
196             .doc(widget.sharedID)
197             .update(
198                 {'notasks': FieldValue.increment(createdTasks.length)});
199         await goalsCollectionRef.doc(widget.goalName).update(
200             {'notasks': FieldValue.increment(createdTasks.length)});
201     }
202 }
203 else {
204     if (widget.sharedGoal) {
205         await SharedGoalManager().addTaskToSharedGoal(
206             sharedID: widget.sharedID ?? '',
207             taskData: taskData,
208             context: context,
209         );
210     } else {
211         // For non-shared goals
212         await goalsCollectionRef
213             .doc(widget.goalName)
214             .collection("tasks")
215             .add(taskData);
216     }
217 }
218
219 LocalNotification.scheduleTaskDueNotification(
220     taskName: _taskNameController.text,
221     dueDate: _selectedDate.add
```

```
208     );
209   } else {
210     // for non-shared goals
211     await goalsCollectionRef
212       .doc(widget.goalName)
213       .collection('tasks')
214       .add(taskData);
215   }
216 }
217
218 localNotification.scheduleTaskDueNotification(
219   taskName: _taskNameController.text,
220   dueDate: _selectedDate.add(
221     Duration(hours: _startTime!.hour, minutes: _startTime!.minute)),
222   goalName: widget.goalName,
223 );
224
225 if (mounted) {
226   Navigator.of(context).pop();
227   ScaffoldMessenger.of(context).showSnackBar(
228     const SnackBar(content: Text('Task added successfully')),
229   );
230   Navigator.pushNamedAndRemoveUntil(context, '/home', (route) => false);
231 }
232 } catch (e) {
233   print("Error creating goal and adding task: $e");  Don't invoke 'print' in production code.-try
234   Navigator.of(context).pop(); // Dismiss loading
235   ScaffoldMessenger.of(context).showSnackBar(
236     SnackBar(content: Text('Error adding task: $e')),
237   );
238 }
239 }
```

Figure 4.3 the code before the slicing for slice #2

Figure 4.4 the code before the slicing for slice #2

```
Future<void> _createGoalAndAddTask() async {
  showLoadingDialog(context);

  final validation = TaskValidator.validate(
    taskName: _taskNameController.text,
    date: _selectedDate,
    startTime: _startTime,
    endTime: _endTime,
    goalDate: widget.goalDate,
  );

  if (!validation.isValid) {
    Navigator.of(context).pop();
    return;
  }

  try {
    final userDocRef = await _taskRepository.getUserDocument();
    CollectionReference goalsCollectionRef = widget.isSharedGoal
        ? FirebaseFirestore.instance.collection('sharedGoal')
        : userDocRef.collection('goals');

    await _taskRepository.createGoal(
      goalName: widget.goalName,
      goalDate: widget.goalDate,
      goalVisibility: widget.goalVisibility,
    );

    taskData = {
      'taskName': _taskNameController.text,
    };
  }
}
```

```
        'date': DateFormat('yyyy-MM-dd').format(_selectedDate!),
        'startTime': _startTime!.format(context),
        'endTime': _endTime!.format(context),
    );
}

if (_selectedRecurrence == "Weekly") {
    await taskManager.addRecurringTask(...);
} else {
    await _taskRepository.addTask(...);
}

LocalNotification.scheduleTaskDueNotification(...);

Navigator.pushNamedAndRemoveUntil(context, '/home', (route) =>
    false);
} catch (e) {
    Navigator.of(context).pop();
}
}
```

Figure 5.1 the code after the slicing for slice #2

Figure 5.2 the code after the slicing for slice #2

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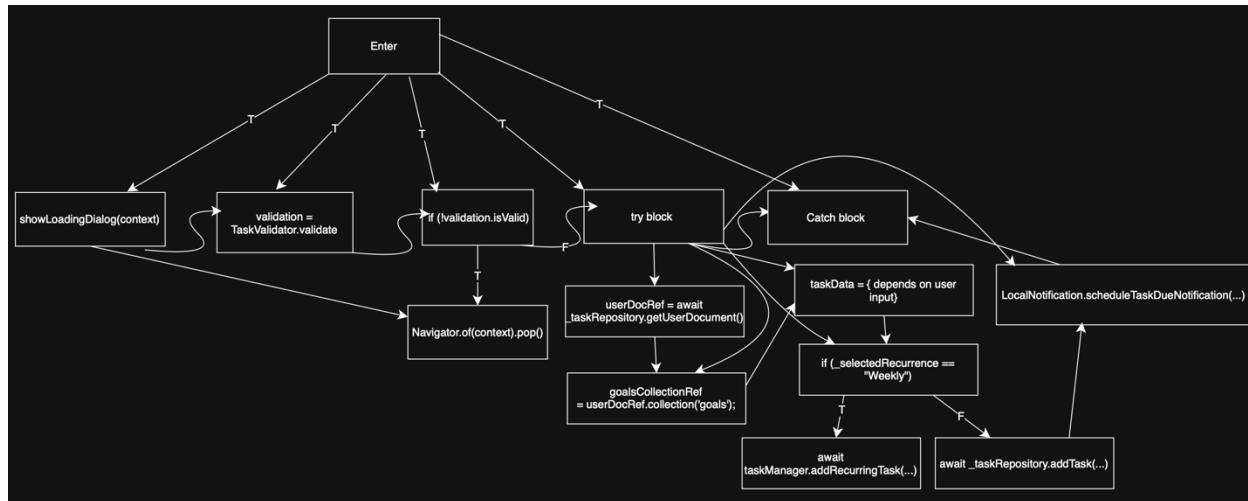


Figure 6 PDG for slice #2

Slice #3

```
169
170     // Add shared tasks stream if sharedId exists
171     if (sharedId != null && sharedId.isNotEmpty) {
172         final sharedTaskStream = FirebaseFirestore.instance
173             .collection('sharedgoal')
174             .doc(sharedId)
175             .collection('tasks')
176             .where('completed', isEqualTo: true)
177             .snapshots()
178             .map((taskSnapshot) {
179                 return taskSnapshot.docs.where((task) {
180                     final completedDate =
181                         (task.data()['completedDate'] as Timestamp)? toDate();
182                     if (completedDate == null) return false;
183
184                     return completedDate.isAfter(today) &&
185                         completedDate.isBefore(tomorrow);
186                 }).length;
187             });
188
189             combinedTaskStreams.add(sharedTaskStream);
190     }
191
192     // Combine personal and shared task streams
193     return Rx.combineLatest(combinedTaskStreams, (List<int> counts) {
194         return counts.reduce((sum, count) => sum + count);
195     });
196
197
198     // If there are no goals, return a stream of 0
199     if (taskStreams.isEmpty) {
200         return Stream.value(0);
201     }
202
203     // Combine all goal task streams
204     return Rx.combineLatest(taskStreams, (List<int> counts) {
205         return counts.reduce((sum, count) => sum + count);
206     });
207 }
208 }
```

Figure 7.1 the code before the slicing for slice #3

Figure 7.2 the code before the slicing for slice #3

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```

134     final userId = FirebaseAuth.instance.currentUser!.uid;
135     final now = DateTime.now();
136     final today = DateTime(now.year, now.month, now.day);
137     final tomorrow = today.add(const Duration(days: 1));
138
139     // Listen to all goals
140     return FirebaseFirestore.instance
141         .collection("Users")
142         .doc(userId)
143         .collection("goals")
144         .snapshots()
145         .switchMap((goalSnapshots) {
146             // Create a stream for each goal's tasks
147             final taskStreams = goalSnapshots.docs.map((goalDoc) {
148                 final goalData = goalDoc.data();
149                 final sharedId = goalData['sharedID'] as String?;
150
151                 // Streams for both personal and shared tasks
152                 final List<Stream<int>> combinedTaskStreams = [

```

Figure 8 the code after the slicing for slice #3



Figure 9 the PDG for slice #3

Slice #4

```

74     Stream<Map<String, dynamic>> getGoalWithProgress() {
75         | DocumentSnapshot goalDocument | {
76             final goalData = goalDocument.data() as Map<String, dynamic>;
77             final userId = FirebaseAuth.instance.currentUser!.uid;
78             final bool isSharedGoal = goalData.containsKey('isShared') && goalData['isShared'] == true;
79
80             // Stream for tasks depends on whether it's a shared or personal goal
81             Stream<QuerySnapshot> tasksStream;
82
83             if (isSharedGoal) {
84                 final sharedId = goalData['sharedID'] as String?;
85                 if (sharedId == null) {
86                     return Stream.value({
87                         'progress': 0.0,
88                         'goalDocument': goalDocument,
89                     });
90                 }
91
92                 // For shared goals, get tasks from sharedGoal collection
93                 tasksStream = FirebaseFirestore.instance
94                     .collection('sharedGoal')
95                     .doc(sharedId)
96                     .collection('tasks')
97                     .snapshots();
98             } else {
99                 // For personal goals, get tasks from user's goals collection
100                tasksStream = FirebaseFirestore.instance
101                    .collection("Users")
102                    .doc(userId)
103                    .collection("goals")
104                    .doc(goalDocument.id)
105                    .collection('tasks')
106                    .snapshots();
107             }
108         }
109     }

```

Figure 10.1 the code before the slicing for slice #3

```

109
110     // Transform the stream to include progress calculation
111     return tasksStream.map((tasksSnapshot) {
112         if (tasksSnapshot.docs.isEmpty) {
113             return {
114                 'progress': 0.0,
115                 'goalDocument': goalDocument,
116             };
117         }
118
119         int completedTasks = tasksSnapshot.docs
120             .where((task) =>
121                 (task.data() as Map<String, dynamic>)[ 'completed'] == true)
122             .length;
123
124         double progress = (completedTasks / tasksSnapshot.docs.length) * 100;
125
126         return {
127             'progress': progress.roundToDouble(),
128             'goalDocument': goalDocument,
129         };
130     });
131 }

```

Figure 10.2 the code before the slicing for slice #3

```

78     final bool isSharedGoal =
79         goalData.containsKey('isShared') && goalData['isShared'] == true;
80
81     // Stream for tasks depends on whether it's a shared or personal goal
82     Stream<QuerySnapshot> tasksStream;
83
84     if (isSharedGoal) {
85         final String sharedId = goalData['sharedID'] as String?;
86         if (sharedId == null) {
87             return Stream.value(
88                 'progress': 0.0,
89                 'goalDocument': goalDocument,
90             );
91         }
92
93         // For shared goals, get tasks from sharedGoal collection
94         tasksStream = FirebaseFirestore.instance
95             .collection('sharedGoal')
96             .doc(sharedId)
97             .collection('tasks')
98             .snapshots();
99     } else {
100         // For personal goals, get tasks from user's goals collection
101         tasksStream = FirebaseFirestore.instance
102             .collection('Users')
103             .doc(userId)
104             .collection('goals')
105             .doc(goalDocument.id)
106             .collection('tasks')
107             .snapshots();
108     }

```

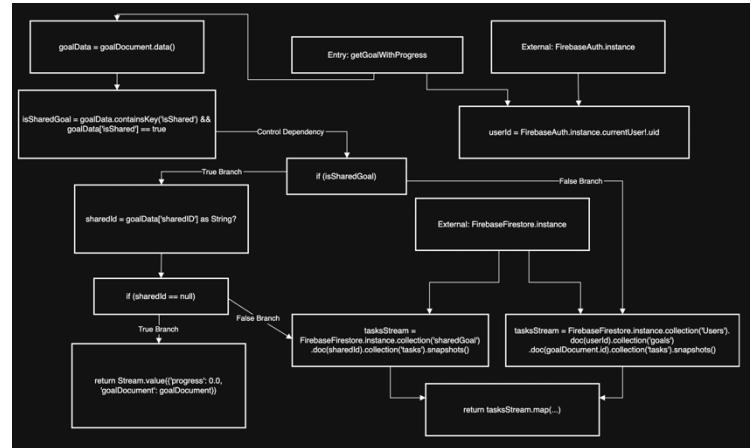


Figure 11 the code after the slicing for slice #3

Figure 12 the PDG for slice #3

Refactoring

After careful review, we have identified the following 4 code smells, and we will go through them in this section

1. Duplicated Code.
2. Large Class.
3. Long Method.
4. Feature Envy.
5. Inconsistent Validation Logic.

1. Add Task Feature Refactoring

This code smell has Duplicate Code, Long Method, Feature Envy, Large Class, and Inconsistent Validation Logic

Why did the code smell?

the add task feature had 2 classes

- 1- **add_task_independitly**: adding a task to a previously added goal
- 2- **add_task**: adding a task for a new goal

we noticed that their behavior is redundant with slight differences

and their Maintenance will become problematic in the future as changes need to be made in both places Also, there is an increased risk of inconsistencies between the two implementations

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Moreover, inside each class, there was a long method (*_createGoalAndAddTask*) impacting the understanding, maintenance, and ability to test individual components. In this method, we were handling date and time with 3 functions :

- *_selectDate(BuildContext context)*: Method to select date
- *_selectStartTime(BuildContext context)*: Method to select the task's start time
- *_selectEndTime(BuildContext context)*: Method to select task's end time

All of these 3 functions had Repeated date/time parsing, some had formatting logic, and No type safety for temporal operations.

Another thing we have noticed that the Database operations were mixed with UI logic which made the Business logic is not properly encapsulated. However, the validation logic was inconsistent it had Different validation approaches in similar forms that made Error handling inconsistent, and validation rules Hard to maintain

The refactoring techniques used and their impact

1. Merge Duplicate Classes (Collapse Hierarchy)

Explanation & Effect:

The project originally contained two classes, *AddTaskPage* and *AddTaskIndependentlyPage*, both implementing very similar functionality with only slight differences. This redundancy introduced risks of inconsistency and made future maintenance more difficult, since changes needed to be replicated across both classes.

To address this, the refactoring technique **Collapse Hierarchy** was applied by merging these two classes into a single configurable class. A Boolean flag (*isIndependent*) was introduced to distinguish between the two behaviors:

If *isIndependent* is true: a task is added to an existing goal.

If false (default): a new goal is created with the task.

This significantly reduced code duplication, improved cohesion, and centralized task-creation logic in one place, making the code easier to read, maintain, and extend.

Affected Elements:

- **Classes:**
 - *AddTaskPage*
 - *AddTaskIndependentlyPage*
 - Both were merged into a unified *AddTaskPage* class with a bool *isIndependent* parameter.
- **Method:**
 - *_createGoalAndAddTask()*
 - This long method was broken down and simplified through extraction of helper methods and delegation to newly created classes.

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- **Variables and Supporting Components:**

- `isIndependent`: A new Boolean flag controlling task behavior.
 - Firestore-related operations were moved to a new class: **TaskRepository**.
 - Date/time operations moved to **DateTimeHelper**.
 - Validation logic moved to **TaskValidator**.

The refactored code was tested to verify that both task-adding flows (independent and with a new goal) still worked as expected.

Figure 213 Before merging classes

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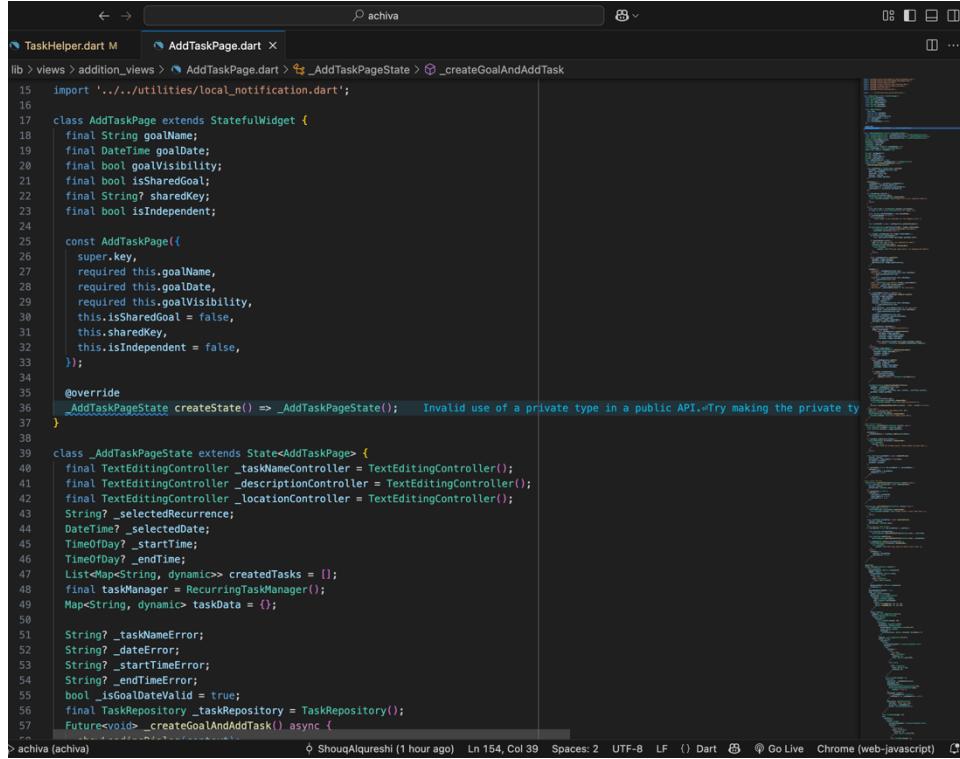

 A screenshot of a code editor showing two files: TaskHelper.dart and AddTaskPage.dart. The code is merged, showing the implementation of the AddTaskPage class and its state. The code includes imports for utilities and local notifications, and defines the AddTaskPage class with required parameters for goalName, goalDate, goalVisibility, isSharedGoal, sharedKey, and isIndependent. It also includes an override for the createState method and the definition of the _AddTaskPageState class. The code editor interface shows tabs for TaskHelper.dart and AddTaskPage.dart, and a status bar at the bottom with file information and icons for Dart, Go Live, and Chrome (web-Javascript).

Figure 14 3After merging AddTaskPage and AddTaskIndependentlyPage

2. Extract Firestore Operations (Extract Class)

Explanation & Effect:

Previously, Firestore logic was tightly coupled with UI logic inside the task-adding components. This violated separation of concerns and made the code harder to test or reuse. The refactoring extracted Firestore logic into a dedicated TaskRepository class, improving structure and allowing better scalability and unit testing.

In this class we have implemented the following functions :

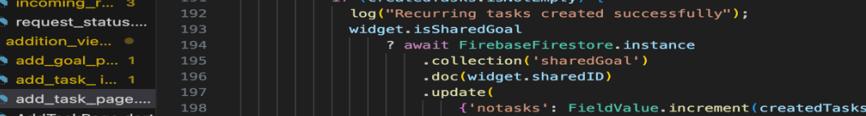
- **getUserDocument()**: it will get the user collection document
- **createGoal()**: will create a goal and handle if the goal is a shared goal or not when the *isIndependent* is false
- **addTask()**: will add a task and handle if the task is for a shared goal or not
- **updateTaskCount()**: After adding a task, this function updates the goal's task counter

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Affected Elements:

- **New Class:**
 - TaskRepository
 - **Methods:**
 - *getUserDocument()*
 - *createGoal()*
 - *addTask()*
 - *updateTaskCount()*

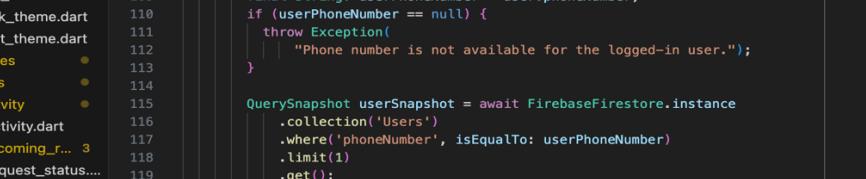
All database operations were tested in isolation, the business logic remained the same, just moved to a cleaner context and refactored methods were verified to handle both shared and personal goals without breaking existing features.



```
activity.dart 190
  incoming_r... 3
  request_status.... 192
  addition_view... 194
  add_goal_p... 1
  add_task_i... 1
  add_task_page... 196
  AddTaskPage.dart 198
  deleteTask.... 1
  editTask.dart 2
  Notification.... 1
  RecurringTaskM... 203
  TaskHelper.... M
  > auth 206
  > FriendsFeed 207
  > onboarding 208
  > profile 210
  > setting 211
  > sharedgoal 212
  > sharedgoal.... 2
  ChatPage.dart 1
  214
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  1934

```

Figure 154 Before TaskRepository class



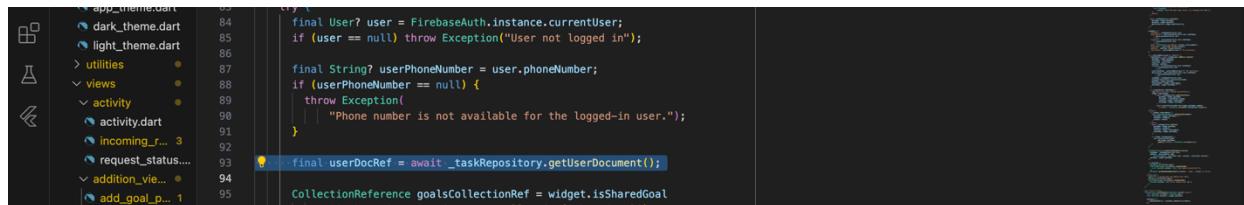
```
  17 final String? userPhoneNumber = user.phoneNumber;
  18 if (userPhoneNumber == null) {
  19   throw Exception(
  20     "Phone number is not available for the logged-in user.");
  21 }
  22
  23 QuerySnapshot userSnapshot = await FirebaseFirestore.instance
  24   .collection('Users')
  25   .where('phoneNumber', isEqualTo: userPhoneNumber)
  26   .limit(1)
  27   .get();
  28
  29 DocumentReference userDocRef;
  30 if (userSnapshot.docs.isEmpty) {
  31   userDocRef =
  32     await FirebaseFirestore.instance.collection('Users').add({
  33       'phoneNumber': userPhoneNumber,
  34     });
  35 } else {
  36   userDocRef = userSnapshot.docs.first.reference;
  37 }
  38
  39 CollectionReference goalsCollectionRef = userDocRef.collection('goals');
  40 DocumentSnapshot goalSnapshot =
  41   await goalsCollectionRef.doc(widget.goalName).get();
```

Figure 16.5 Before TaskRepository class

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```

app_theme.dart 65
dark_theme.dart 84
light_theme.dart 85
utilities 86
views 88
activity 89
activity.dart 90
incoming_r... 91
request_status... 93
addition_vie... 94
add_goal_p... 1
  
```

```

city
final User? user = FirebaseAuth.instance.currentUser;
if (user == null) throw Exception("User not logged in");

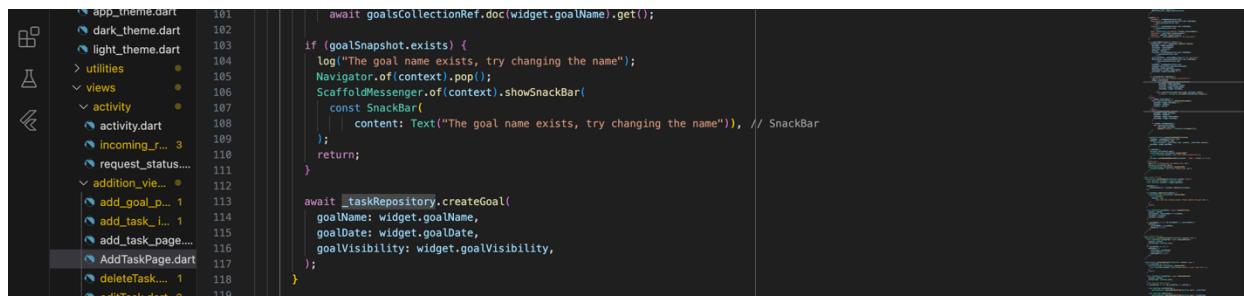
final String? userPhoneNumber = user.phoneNumber;
if (userPhoneNumber == null) {
  throw Exception(
    "Phone number is not available for the logged-in user.");
}

final userDocRef = await _taskRepository.getUserDocument();
  
```

```

CollectionReference goalsCollectionRef = widget.isSharedGoal
  
```

Figure 17 6 After TaskRepository class



```

app_theme.dart 101
dark_theme.dart 102
light_theme.dart 103
utilities 104
views 106
activity 107
activity.dart 108
incoming_r... 109
request_status... 110
addition_vie... 111
add_goal_p... 1
add_task_i... 1
add_task_page... 1
AddTaskPage.dart 116
deleteTask... 117
editTask.dart 118
editTask.dart 119
  
```

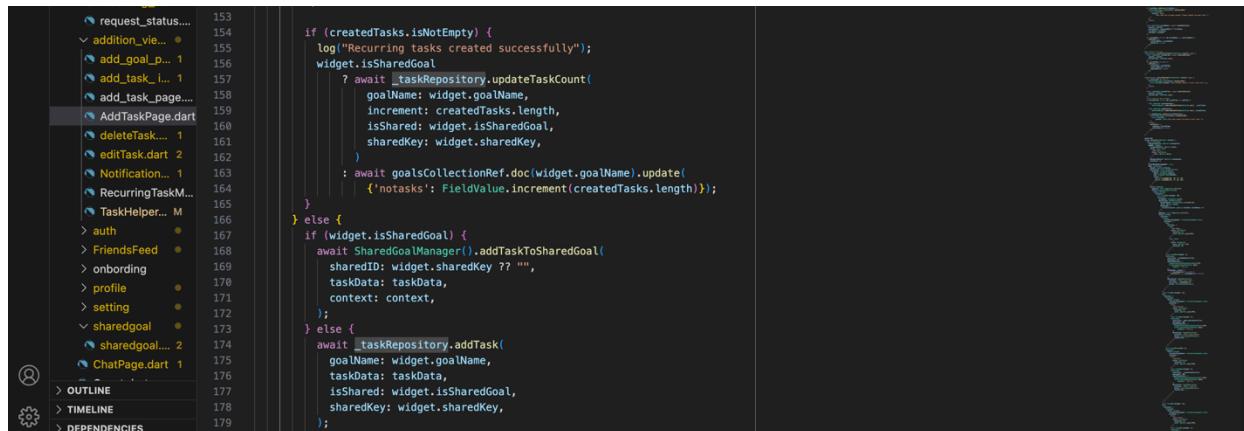
```

await goalsCollectionRef.doc(widget.goalName).get();

if (goalSnapshot.exists) {
  log("The goal name exists, try changing the name");
  Navigator.of(context).pop();
  ScaffoldMessenger.of(context).showSnackBar(
    const SnackBar(
      content: Text("The goal name exists, try changing the name"),
    ),
  );
  return;
}

await _taskRepository.createGoal(
  goalName: widget.goalName,
  goalDate: widget.goalDate,
  goalVisibility: widget.goalVisibility,
);
  
```

Figure 18 7 After TaskRepository class



```

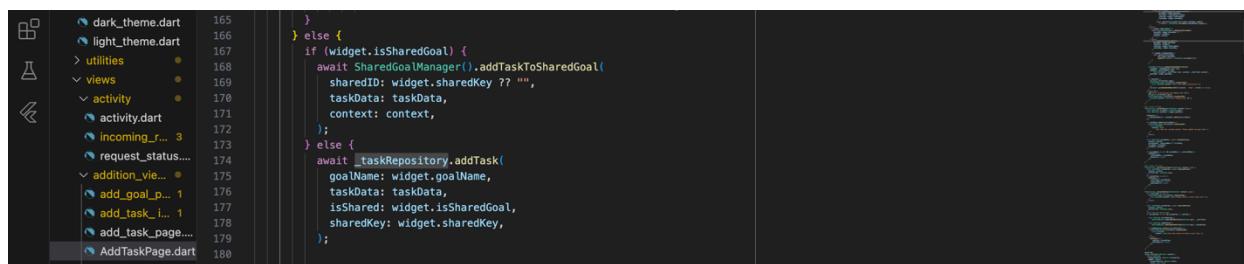
request_status... 153
addition_vie... 154
add_goal_p... 155
add_task_i... 156
add_task_page... 157
AddTaskPage.dart 158
deleteTask... 159
editTask.dart 160
editTask.dart 161
Notification... 163
RecurringTaskM... 164
TaskHelper... M 165
auth 166
FriendsFeed 168
onboarding 169
profile 170
setting 172
sharedgoal 173
sharedgoal... 2 174
ChatPage.dart 1 175
  
```

```

if (createdTasks.isNotEmpty) {
  log("Recurring tasks created successfully");
  widget.isSharedGoal
    ? await _taskRepository.updateTaskCount(
        goalName: widget.goalName,
        increment: createdTasks.length,
        isShared: widget.isSharedGoal,
        sharedKey: widget.sharedKey,
      )
    : await goalsCollectionRef.doc(widget.goalName).update(
        {'notasks': FieldValue.increment(createdTasks.length)});
}

else {
  if (widget.isSharedGoal) {
    await SharedGoalManager().addTaskToSharedGoal(
      sharedID: widget.sharedKey ?? "",
      taskData: taskData,
      context: context,
    );
  } else {
    await _taskRepository.addTask(
      goalName: widget.goalName,
      taskData: taskData,
      isShared: widget.isSharedGoal,
      sharedKey: widget.sharedKey,
    );
  }
}
  
```

Figure 819 After TaskRepository class



```

dark_theme.dart 165
light_theme.dart 166
utilities 167
views 168
activity 169
activity.dart 170
incoming_r... 172
request_status... 173
addition_vie... 174
add_goal_p... 176
add_task_i... 177
add_task_page... 178
AddTaskPage.dart 179
  
```

```

}
else {
  if (widget.isSharedGoal) {
    await SharedGoalManager().addTaskToSharedGoal(
      sharedID: widget.sharedKey ?? "",
      taskData: taskData,
      context: context,
    );
  } else {
    await _taskRepository.addTask(
      goalName: widget.goalName,
      taskData: taskData,
      isShared: widget.isSharedGoal,
      sharedKey: widget.sharedKey,
    );
  }
}
  
```

Figure 209 After TaskRepository class

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3. Create DateTime Helper (Extract Method)

Explanation & Effect:

Date and time operations were duplicated and inconsistently handled across multiple functions. The refactoring extracted shared logic into a `DateTimeHelper` class, centralizing formatting and combining logic. This improved consistency, reduced duplication, and made future changes easier.

Affected Elements:

- New Class:
 - `DateTimeHelper`
- Methods:
 - `combineDateWithTime(DateTime date, TimeOfDay time)`
 - `formatForDisplay(DateTime date)`

All date and time-related functions now share one reliable implementation, refactoring was verified against all input formats and edge cases. better type safety reduced bugs from invalid or unparsed date strings.



```

    ◈ incoming_request_v... 3
    ◈ request_status.dart
    ✓ addition_views
    ◈ add_goal_page.dart 1
    ◈ add_task_independ... 1
    ◈ add_task_page.dart
    ◈ AddTaskPage.dart
    ◈ deleteTask.dart 1
    ◈ editTask.dart 2
    ◈ NotificationHandlingf... 1
    ◈ RecurringTaskManager.dart
    ◈ TaskHelper.dart M
    > auth
    > FriendsFeed
    > onboarding
    264
    265 if (pickedTime != null && pickedTime != _endTime) {
    266 // Convert both times to DateTime for comparison
    267 final DateTime startDateTime = DateTime(
    268     DateTime.now().year,
    269     DateTime.now().month,
    270     DateTime.now().day,
    271     _startTime!.hour,
    272     _startTime!.minute,
    273 ); // DateTime
    274 final DateTime endDateTime = DateTime(
    275     DateTime.now().year,
    276     DateTime.now().month,
    277     DateTime.now().day,
    278     pickedTime.hour,
    279     pickedTime.minute,
    280 ); // DateTime
    281
  

```

Figure 2110 Before `combineDateWithTime()` function

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```

Future<void> _selectEndTime(BuildContext context) async {
  if (_startTime == null) {
    ScaffoldMessenger.of(context).showSnackBar(
      const SnackBar(content: Text('Please select a start time first.')),
    );
    return;
  }

  final TimeOfDay? pickedTime = await showTimePicker(
    context: context,
    initialTime: TimeOfDay.now(),
  );
  //new time has been picked
  if (pickedTime != null && pickedTime != _endTime) {

    final DateTime startDateTime =
      DateTimeHelper.combineDateWithTime(DateTime.now(), _startTime);

    final DateTime endDateTime =
      DateTimeHelper.combineDateWithTime(DateTime.now(), pickedTime);

    if (endDateTime.isBefore(startDateTime)) {
      ScaffoldMessenger.of(context).showSnackBar(
        const SnackBar(
          content: Text('End time cannot be before start time.')), // SnackBar
      );
    } else {
      setState(() {
        _endTime = pickedTime;
        _endTimeError = null;
      });
    }
  }
}
  
```

Figure 1122 After combineDateWithTime() function

4. Simplify Validation (Consolidate Conditionals)

Explanation & Effect:

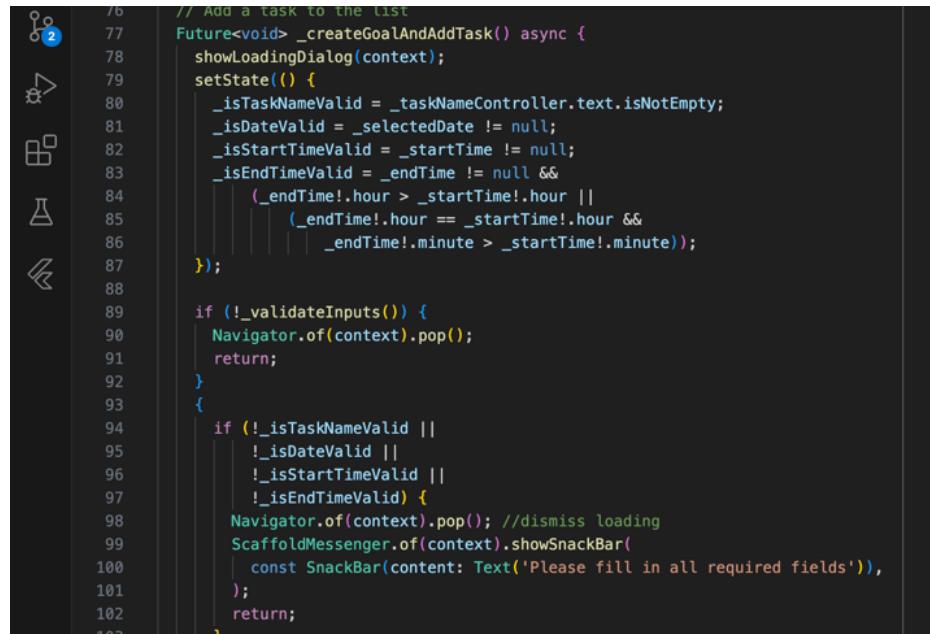
The app had inconsistent validation logic scattered across different forms, making it error-prone and hard to maintain. The refactoring introduced a TaskValidator class to standardize validations, reduce duplication, and unify error messaging, which enhanced both reliability and clarity.

Affected Elements:

- New Class:
 - **TaskValidator**
- Functions:
 - **Centralized validation rules and messages**

All validation flows were tested to match previous behavior, consolidation ensures consistency across the UI, the centralized logic can be easily updated and reused across features.

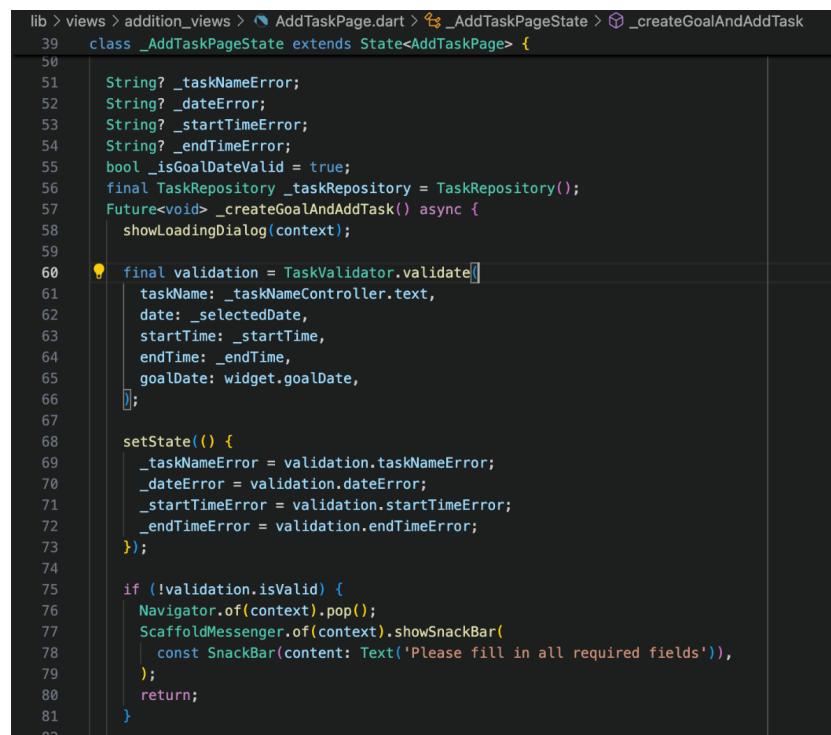
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```

76  // Add a task to the list
77  Future<void> _createGoalAndAddTask() async {
78    showLoadingDialog(context);
79    setState(() {
80      _isTaskNameValid = _taskNameController.text.isNotEmpty;
81      _isDateValid = _selectedDate != null;
82      _isStartTimeValid = _startTime != null;
83      _isEndTimeValid = _endTime != null &&
84        (_endTime!.hour > _startTime!.hour ||
85         (_endTime!.hour == _startTime!.hour &&
86          _endTime!.minute > _startTime!.minute));
87    });
88
89    if (!validateInputs()) {
90      Navigator.of(context).pop();
91      return;
92    }
93    {
94      if (!_isTaskNameValid ||
95          !_isDateValid ||
96          !_isStartTimeValid ||
97          !_isEndTimeValid) {
98        Navigator.of(context).pop(); //dismiss loading
99        ScaffoldMessenger.of(context).showSnackBar(
100          const SnackBar(content: Text('Please fill in all required fields')),
101        );
102      }
103    }
  
```

Figure 23 12 Before TaskValidator class



```

39  lib > views > addition_views > AddTaskPage.dart > _AddTaskPageState > _createGoalAndAddTask
40  class _AddTaskPageState extends State<AddTaskPage> {
41
42    String? _taskNameError;
43    String? _dateError;
44    String? _startTimeError;
45    String? _endTimeError;
46    bool _isGoalDateValid = true;
47    final TaskRepository _taskRepository = TaskRepository();
48    Future<void> _createGoalAndAddTask() async {
49      showLoadingDialog(context);
50
51      final validation = TaskValidator.validate(
52        taskName: _taskNameController.text,
53        date: _selectedDate,
54        startTime: _startTime,
55        endTime: _endTime,
56        goalDate: widget.goalDate,
57      );
58
59      setState(() {
60        _taskNameError = validation.taskNameError;
61        _dateError = validation.dateError;
62        _startTimeError = validation.startTimeError;
63        _endTimeError = validation.endTimeError;
64      });
65
66      if (!validation.isValid) {
67        Navigator.of(context).pop();
68        ScaffoldMessenger.of(context).showSnackBar(
69          const SnackBar(content: Text('Please fill in all required fields')),
70        );
71      }
72    }
73
74
75    if (!validation.isValid) {
76      Navigator.of(context).pop();
77      ScaffoldMessenger.of(context).showSnackBar(
78        const SnackBar(content: Text('Please fill in all required fields')),
79      );
80    }
81  }
  
```

Figure 24 13 After TaskValidator class

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5. Extract Form Validation (Extract Method)

Created a dedicated ***isValidForm(BuildContext context)*** method to handle all form validation logic. In this method, we have implemented the following checks:

- **Empty Fields Check:** Ensures that first name, last name, and email are not empty.
- **Gender Selection:** Validates that the user has selected a gender option.
- **Email Format Validation:** Checks whether the entered email matches a valid pattern.

This method also shows a contextual **SnackBar** message for each validation case when the input is invalid.

Impact:

- Removed repeated validation logic from multiple locations in the UI logic.
- Simplified the ***updateUserData()*** method and the form submission button callback.
- Improved readability and maintainability of the code.
- Easier future modification of validation rules in a single location.

```

71  }
72
73 Future<void> updateUserData() async {
74   try {
75     // Validate input fields
76     if (_fnameController.text.isEmpty ||
77         _lnameController.text.isEmpty ||
78         _emailController.text.isEmpty ||
79         widget.layoutCubit.chosenGender == null) {
80       showSnackBarWidget(
81         message: "Please fill in all fields",
82         successOrNot: false,
83         context: context
84       );
85       return;
86     }
87
88     // Check if email is already in use by another user
89     if (await checkIfEmailExists(_emailController.text) &&
90         _emailController.text != widget.layoutCubit.user!.email) {
91       ...
92     }
93   }
94 }
```

 Figure 1425 Before *isValidForm* method

```
64
65  bool isFormValid(BuildContext context) {
66    if (_fnameController.text.isEmpty ||
67        _lnameController.text.isEmpty ||
68        _emailController.text.isEmpty ||
69        widget.layoutCubit.chosenGender == null) {
70      showSnackBarWidget(
71        message: "Please fill in all fields",
72        successOrNot: false,
73        context: context,
74      );
75      return false;
76    }
77    if (!isValidEmail(_emailController.text)) {
78      showSnackBarWidget(
79        message: "Please enter a valid email address",
80        successOrNot: false,
81        context: context,
82      );
83      return false;
84    }
85    return true;
86  }
87
```

Figure 1526 After isFormValid method

Maintainability Improvements

1. Enhanced Code Organization

- **Merged Duplicate Classes:** By consolidating AddTaskPage and AddTaskIndependentlyPage into a single class, we eliminated redundancy
- **Extracted Repository Pattern:** The new TaskRepository class provides a single source of database operations, making future changes to data access easier to implement.
- **Dedicated DateTime Helper:** Time operations are now in one place, improving consistency and reducing the chance of bugs in date/time handling.

2. Improved Readability

- **Simplified Validation Logic:** The TaskValidator class makes validation rules explicit and easy to understand.
- **Better Separation of Concerns:** UI logic is now separate from business logic and database operations.
- **Consistent Error Handling:** Validation errors are now handled uniformly throughout the adding task feature.

3. Easier Maintenance

- **Single Point of Modification:** Changes to task creation logic now only need to be made in one place instead of two.
- **Reduced Method Length:** Breaking down the oversized `_createGoalAndAddTask` method into smaller, focused methods has made the code more manageable.

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