

INM 330: Software Systems Design

Coursework 2023

1 Specification of a design model for an expense management system

This part of the coursework requires you to specify a design model for an **EX**penditure **MA**nagement **S**ystem (**EXMAS**). This system is described in Section 2 below. The design model that you are required to construct must include an architecture model for EXMAS, and a detailed design model consisting of design class and object interaction diagrams for the some of the use cases of EXMAS. **This part of the coursework carries 50% of the aggregate coursework mark.**

2 System Overview

EXMAS will be developed to support the management (i.e., recording, reviewing, clearing, monitoring, and auditing) of expenses, which are made by the employees of different organisations and are related to the business activities of their organisations.

More specifically, EXMAS should support:

- **Recording of expense claims** – EXMAS should support the recording of expenses made by different employees of an organisation (e.g., travel costs, hospitality expenses etc.) and the uploading of documentation (e.g., scanned copies of receipts, invoices, tickets etc.) that provides evidence of the occurrence of these expenses.
- **Reviewing and handling of expense claims** – EXMAS should support the reviewing of recorded expenses by employees of an organisation, who have appropriate authorisation rights for this, and the recording of decisions regarding the handling of such expenses (e.g., their approval, rejection or referral).
- **Recording of expense claim payments** – EXMAS should support the recording of any payments made for approved expense claims.
- **Audit of the expense management process of an organisation** – EXMAS should support a full audit of the expense management process within an organisation. This capability should be available to different users who participate in the expense management process depending on their role. Individual claimants should, for instance, be able to view the full trace of the steps through which each of the expense claims that they have submitted has been processed; claim approvers should be able to view the full trace of the processing of each of the expense claims that they have dealt with, and claim authorization and payment confirmation signatories should be able to view and audit aggregate reports regarding expense claims (e.g., the total amount of expenditure for claims of a given type, for claims related to individual organization units or cost codes etc.). The same capability should also support the provision of paper reports for external auditors.

A more detailed description of the functionality of EXMAS is given by the use case model specified in Appendix A.

3 Your tasks

Your tasks for the coursework will be to develop:

- (i) An **architecture model** for EXMAS. The architecture **model** to be developed **must follow the MVC style**. In developing this model, you should consider ALL the use cases of EXMAS, specified in Appendix A.
- (ii) A **detailed design model** for EXMAS, including a design class diagram and a design sequence diagram **covering only the use cases *Claimant Audit (Use Case: 10)* and *Claim Signatory Audit (Use Case: 11)***. Note that it WILL NOT BE NECESSARY to

specify sequence diagrams for any additional use cases which may be included in or extend the above use cases.

Before developing the above models, you should carefully read the marking scheme of the coursework, which is given in Appendix B.

All the above models must be **developed using a modelling tool supporting UML** (e.g., Magic Draw or another tool of your choice that supports UML) and **submitted in PDF format in Moodle by 17.00 on 26/11/2023**.

Appendix A: Use Case Model for EXMAS

Use Case Descriptions

Name: Login
ID: 01
Actor: User
Preconditions:
Flow of events: 1. REPEAT 1.1. The system prompts the user to enter his/her username and password. 1.2. The user enters his/her username and password. 1.3. DO EXTEND <i>Authenticate</i> UNTIL user is authenticated or more than three authentication attempts have been made 2. IF user is authenticated THEN 2.1 The system logs the user in. ELSE 2.2 The system displays an error message to indicate that maximum number of wrong login attempts has been reached. END IF
Post conditions:

Name: Authenticate
ID: 02
Actor:
Preconditions: User name and password are available to check
Flow of events: 1. The system checks the provided user username and password 2. IF both the username and password are correct THEN 2.1 The user is authenticated ELSE 2.2 The user is not authenticated END IF
Post conditions:

Name: Employee Registration
ID: 03
Actor: Administrator
Preconditions:
Flow of events: 1. The user selects the registration option. 2. The system prompts the user to enter the name, address, telephone numbers, e-mail address (if any) and organizational unit of an employee. 3. The user enters the requested information.

4. The system registers the user and creates a login name and creates a password for him/her.
5. The system notifies the employee of his/her password by sending an email to his/her recorded email address.
6. The system informs the user of the completion of the registration.
Post conditions: The user is registered.

Name: Record claim
ID: 04
Actor: User
Preconditions: The user is logged in
Flow of events: IF the user is eligible to submit expense claims THEN <ol style="list-style-type: none"> 1. The system asks the user to provide a name for the new expense claim 2. The user provides the requested information 3. The system creates an empty expense claim and prompts the user to specify the individual items of expenditure that will be covered by it. 4. REPEAT <ol style="list-style-type: none"> 4.1 The system presents the items recorded under the claim and asks the user to confirm whether he/she wants to edit, save or delete the claim. IF the user wishes to edit the claim THEN <ol style="list-style-type: none"> 4.2 DO EXTEND Edit Claim ELSE IF the user wishes to discard the claim THEN <ol style="list-style-type: none"> 4.3 The system discards the claim. ELSE <ol style="list-style-type: none"> 4.4 The system saves the claim. END IF UNTIL the claim is saved or deleted ELSE <ol style="list-style-type: none"> 6. The system informs the user that he/she is not eligible to submit an expense claim END IF
Post conditions:

Name: Edit Claim
ID: 05
Actor: User
Preconditions: The user is logged in; a claim is selected; the user is eligible to submit an expense claim
Flow of events: REPEAT <ol style="list-style-type: none"> 1. The system prompts the user to specify a new item for the claim by indicating: (a) the type of the expenditure item (e.g., travel tickets, hotel expenses, meal expenses); (b) the amount of the incurred expenditure; (c) the currency in which the expenditure has been incurred; (d) the exact date on which the expenditure was made; and (d) evidence of the expenditure by uploading the relevant documentation (e.g., a receipt, an invoice, a ticket etc.) or close the claim. 2. The user provides any of the information elements (a)-(d) for the item and asks the

<p>system to record it, or requests to close the claim.</p> <p>3. IF the user has provided new information for the item THEN</p> <p> 3.1 The system checks the compliance of the provided information against the policy (e.g., that the amount for the item is within the expected boundaries etc)</p> <p> WHILE the information provided is not compliant and no request to close the claim has been made DO</p> <p> 3.2 The system highlights the information element(s) that need to be amended and prompts the user to fix them.</p> <p> 3.3 The user amends the information elements and asks the system to record it, or requests to close the claim.</p> <p> END WHILE</p> <p> IF the information provided is compliant THEN</p> <p> 3.4 The system saves the information provided.</p> <p> END IF</p> <p>END IF</p> <p>UNTIL no request to close the claim has been received.</p> <p>Post conditions: Claim items are recorded</p>

Name: Review claims
ID: 06
Actor: User with claim authorisation rights
Preconditions: The user is logged in
<p>Flow of events:</p> <ol style="list-style-type: none"> 1. The presents the expense claims under the responsibility of the particular user, and prompts him/her to select one to review. 2. The user selects an expense claim or exits the process. 3. IF an expense claim is selected THEN <ol style="list-style-type: none"> 3.2 DO EXTEND Review claim <p>END IF</p>
Post conditions:

Name: Review claim
ID: 07
Actor: User with claim authorisation rights (authorization signatory)
Preconditions: The user is logged in; a claim has been selected for review
<p>Flow of events:</p> <ol style="list-style-type: none"> 1. The system presents the items of the claim to be reviewed. 2. REPEAT <ol style="list-style-type: none"> 2.1 The user selects a claim item or closes the claim. IF an item is selected THEN <ol style="list-style-type: none"> 2.2. The system presents the details of the claim item. 2.3 The user may select the option of recording an enquiry about the item, approve it, or close it. 2.4 IF the item enquiry option is selected THEN <ol style="list-style-type: none"> 2.4.1 The system prompts the user to type in the enquiry about the item. 2.4.2 The user types in the enquiry about the item and asks the system to

<p>save it.</p> <p>2.4.3 The system saves the enquiry and informs the owner of the claim that there is an enquiry for the item.</p> <p>2.5 ELSE IF the item is approved THEN</p> <p>2.5.1 The item is recorded as approved.</p> <p>2.6 ELSE</p> <p>2.6.1 The item is closed.</p> <p>ENDIF</p> <p>ENDIF</p> <p>UNTIL the user selects the option to close the claim</p> <p>3. The system closes the claim.</p>
Post conditions:

Name: Authorise Claim
ID: 08
Actor: User with claim authorisation rights
Preconditions: The user is logged in
<p>Flow of events:</p> <ol style="list-style-type: none"> 1. The system presents the list of expense claims under the responsibility of the particular user that have all their items approved. 2. The user selects an expense claim. 3. The system shows all the items recorded under it. 4. The user selects one of two options: (a) to authorise the claim for payment, or (b) to review it further. 5. IF option (a) is selected THEN <ol style="list-style-type: none"> 5.1. The system records the authorisation of payment and notifies the accounts department. <p>ELSE</p> <ol style="list-style-type: none"> 5.2 DO EXTEND Review Claim <p>END IF</p>
Post conditions:

Name: Pay Claim
ID: 09
Actor: User with claim payment rights;
Preconditions: User is logged in
<ol style="list-style-type: none"> 1. The system presents the list of expense claims that have been authorised for payment. 2. The user selects an expense claim from the list. 3. The system shows all the items recorded under it. 4. The user selects one of two options: (a) to confirm the claim for payment, or (b) to review it further. 5. IF option (a) is selected THEN <ol style="list-style-type: none"> 5.1 The system records the confirmation of payment and notifies the accounts department. <p>ELSE</p> <ol style="list-style-type: none"> 5.2 DO EXTEND Review Claim

END IF
Post conditions:

Name: Claimant audit
ID: 10
Actor: User
Preconditions: User is logged in
<ol style="list-style-type: none"> 1. The system presents the list of expense claims made by the user. 2. The user selects an expense claim from the list. 3. The system shows the claim enquiry, payment authorisation, and payment confirmation actions recorded against it along with the relevant dates. 4. The user closes the claim.
Post conditions:

Name: Claim signatory audit
ID: 11
Actor: Claim signatory user
Preconditions: User is logged in
<ol style="list-style-type: none"> 1. The system presents a list of options for selecting claims approved by the specific signatory. These options allow the selection of claims by: (a) their type, (b) the organization unit they relate to, (c) the cost code they relate to, (d) the claimant that made them, or (e) the period within which they were approved and/or paid. 2. The user selects one of the options (a)-(e) or quits the process. 3. The user selects an option. 4. IF one of the options (a)-(e) is selected THEN <ol style="list-style-type: none"> 4.1. The system prompts the user to provide the relevant claim selection information. 4.2. The user provides the criterion. 4.3. The system retrieves and presents the relevant list of claims. 4.4. The user may select one of the retrieved claims or quit the process. 4.5 IF a claim is selected THEN <ol style="list-style-type: none"> 4.5.1. The system shows the claim enquiry, payment authorisation, and payment confirmation actions recorded against it along with the relevant dates. <p>ELSE</p> <ol style="list-style-type: none"> 4.5.2. The process is ended. <p>END IF</p> <p>ELSE</p> <ol style="list-style-type: none"> 4.6. The process is ended. <p>END IF</p>
Post conditions:

Appendix B: Marking Scheme

Marking criterion		Mark	Out Of
Part (i): Architecture model (40 marks)	Specification of system components	--	12
	Specification of component interfaces (the interfaces should cover ALL the functional capabilities of the system that have been described in the use cases of the system).	--	12
	Specification of realisation relationships between components and interfaces	--	5
	Specification of use relations between components and interfaces	--	5
	Description of the architectural style used in the architectural model and clear identification of the roles that the individual components of the model have in reference to the style.	--	6
Part (ii): Structural Design Model (25 marks)	Specification of plausible control, entity, boundary and classes required for realising the components of the architectural model.		
	Control classes (should cover control for all the different components and control for the overall system)	--	5
	Entity classes (should cover the persistent data of the system and the data transmitted during executions)	--	5
	Boundary classes (should cover interactions with all external system actors)	--	2
	Correctness of		
	<ul style="list-style-type: none"> Attributes (expression of class properties, correct type, no redundancy) 	--	3
	<ul style="list-style-type: none"> Associations (names, correct multiplicities, assoc. classes if necessary) 	--	3
Behavioural Design Model (Sequence diagrams) (35 marks)	<ul style="list-style-type: none"> Operations (should cover all operations defined in the interfaces, should have sufficient parameters covering the data needed for and produced by the execution of the operation) 	--	5
	<ul style="list-style-type: none"> Generalisation relations 	--	2
	Coverage of system functionality specified in target use cases	--	10
	<i>Correctness of flow of control</i>		
	<ul style="list-style-type: none"> Existence of message activators 	--	5
	<ul style="list-style-type: none"> Messages to show <<includes>> and <<extends>> relations 	--	2
	<ul style="list-style-type: none"> Appropriate handling of data storage (where applicable) 	--	5
	<ul style="list-style-type: none"> Plausible interactions with external actors/users 	--	3
	<ul style="list-style-type: none"> Specification of iterations/conditions as necessary 	--	2
	Messages must correspond to operations in class diagrams developed for A.(ii)	--	3
	Messages must have full signatures & sufficient arguments	--	3
	The classes of objects in SDs are specified and exist in the class diagrams	--	2
Total Mark		--	100