IndEAA

Streamlining course review by industry advisory panels

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Contents

1 Acronyms, Abbreviations and Definitions

- UWA: The University of Western Australia
- IAP: Industry Advisory Panel
- EA: Engineers Australia
- EOC: Element of Competency: the basis of the review process. For the purposes of this document, from P05PE Revision 3 by EA.
- IOA: Indicator of Attainment
- DL: Development Level
- Reviewer: A member of a specific IAP evaluating a specific UWA unit against a set of EOCs
- Coordinator: A member of UWA academic staff coordinating the review of a UWA unit
- The Solution, The Tool, The System, The Website, The App or The Portal: The new system being proposed in this document to streamline the existing IAP Review Process

2 Aim and scope

Within the UWA IAP MECH5551 and MECH552 review sub-committee, as part of Engineers Australia accreditation , the process for review is unclear in instruction, inefficient in execution and confusing in final interpretation. The solution will remove these inefficiencies and ambiguities, creating a review process which produces more reliable results in less time.

This project develops a webtool to streamline this process for engineer industry advisory panels to conduct unit reviews.

As of early 2020, there are 51 institutions with EA accredited programs in Australia. Each institution is required to maintain an Industry Advisory Panel, which reviews unit materials to confirm that the elements of competency for engineers are being met at an appropriate level. Each institution has scores of units, which are reviewed on a quinquennial basis.

Table 1: Issues with current procedure

Issue	**Impact**	**The Solution**
EOC's are given by reference number	Requires navigation to additional documents to understand the meaning of the EOC	Will display information dynamically as-needed and be adaptable for the user, allowing them to hide the information required
Preparing for process requires collating multiple resources into excel spreadsheet	Time loss. Discards formatting of source documents, creating ambiguity	Coordinators can upload documents and/or provide hyperlinks. The system will provide resources via downloads and hyperlinks which will be presented to the reviewer when needed.
Unintuitive output format **3.3**	Matrix entries are unclear in meaning and do not meaningfully translate to the EOC attainment. Output is created inconsistently. Output suggests that planned outcomes determine EOC attainment, rather than actual unit-work and assessments	Will have users holistically review unit outline, unit materials and assessments and make an overall evaluation of each EOC.
Comments are rarely collected on unit material or pre-assigned DLs for each EOC	Current process does not realise the potential for significant constructive feedback from the industry experts	Reviewers will select a DL for each EOC and provide qualitative comment.
Reviewers require pheme credentials to access LMS	Creates unnecessary tasks for reviewers and the UWA IT staff, including those related to credential expiration. Navigating LMS is often complex, and older IAP members are unfamiliar with the system.	Will use Google Sign-in for login, which is easy to implement and is built on industry standard technology. Documents will be presented when needed, removing navigational complexity

3 Base case

3.1 Procedure

The current procedure, used for the review of MECH5552 is as follows. The issues with this procedure are outlined in greatest detail in Table 1

- The review coordinator collects unit materials to be reviewed, and uploads them to the Blackboard Learning Management System (LMS). The IAP members are supposed to access the LMS to review materials.
- The IAP reviewers obtain documents, specifying EOCs, IOAs, and DLs. These need to be reviewed
- The reviewers assess the course, creating the spreadsheet specified in Subsection **3.3**
- The individual spreadsheets created by the reviewers needs to be collated by the review coordinator. This is a manual exercise

3.2 Inputs to Current System

- Unit outlines with outcomes and outcome assessments
- Specifications for EOCs, Dls and IOAs
- Documents related to assessment tasks (descriptions, marking rubrics, complete projects)
- Examples of completed IAP review outputs
- The technical and professional knowledge of the reviewers
- Instructions and guidance on completing the review from the coordinator

3.3 Outputs from Current System

- Primary output: A 2D matrix with rows being labelled by unit outcomes and columns labelled by EOCs at the desired DL. Within the matrix, a cell being filled (with a cross) represents the reviewers belief that a unit outcome contributes to the attainment of the EOC at a specific DL. An example of this output, which is independently created by each IAP reviewer, is shown in Figure 1
- Secondary output (occasional): Unstructured qualitative comments from reviewers assessing whether the assigned DL for each EOC is appropriate given the scope of the unit.

			Elements of Competency																				
			1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5
			Development Levels																				
	MECH5551	Mechanical Engineering Design	4	4	4	3	3	4	4	4	4	3	3	4	3	4	3	4	3	3	4	3	3
#	Outcome	How outcome will be assessed																					
1	apply engineering synthesis and design processes relevant to mechanical engineering	reflective writing; project deliverables	x		x		x	x	x	x	x	x	x		x	x			x	x	x	x	x
2	seek out the requirements and associated resources to assess the scope, dimensions, scale of effort and indicative costs of a complex engineering project;	project deliverables	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x
3	apply technical knowledge, appropriate tools and problem-solving skills to achieve a desired outcome to satisfy user requirements;	project deliverables	x	x	x		x	x	x	x		x			x				x	x	x		x
4	apply project management tools and processes to the planning and execution of a design project;	reflective writing; project deliverables; professional conduct					x	x	x	x	x	x	x	x		x	x	x		x	x	x	
5	conduct oneself in a professional manner;	reflective writing; project deliverables; professional conduct									x	x	x	x			x					x	x
6	critically analyse design inputs, processes and outputs;	reflective writing; project deliverables	x		x	x	x	x	x	x			x		x				x	x	x		x
7	locate and evaluate relevant standards and technical literature	project deliverables			x		x	x	x	x	x	x	x			x				x	x		x
8	use discourse conventions relevant to the discipline	project deliverables			x		x	x	x	x	x	x		x				x		x	x		x
9	communicate clearly, effectively and appropriately using written, oral and visual means	reflective writing; project deliverables; professional conduct										x		x		x	x	x		x	x	x	x
10	contribute to and/or manage a complex engineering project activity, as a member and/or leader of an engineering team.	reflective writing; project deliverables; professional conduct									x	x	x	x		x	x	x				x	

Figure 1: Example output for undergraduate unit

4 Development methodology and overview

This project will create an online system replacing the current procedure described in Section **3.1**. The user-facing element of the system is an online portal which both coordinators and reviewers can access. The portal will allow coordinators to organise the review of a unit, including uploading or linking to materials and assigning reviewers to a unit. The assigned reviewers will be guided through a streamlined process in which they review all materials presented to them and then assess each EOC for the unit as one of the presented DLs. The coordinator will be able to track the reviewer's process and access the review once it is completed. The portal will also support one or more administrators who will manage the portal for their institution through adding and removing coordinators and additional administrators.

The system will be developed in two stages. The goal of the first stage is to develop the prototype required for the coordination of the upcoming MECH551 and MECH5552 review. The system design will be built for two types of users: coordinators and reviewers.

Following this, the second stage of development will create a more general purpose product including one which will add a third class of users — administrators — which can add or remove coordinators from the system.

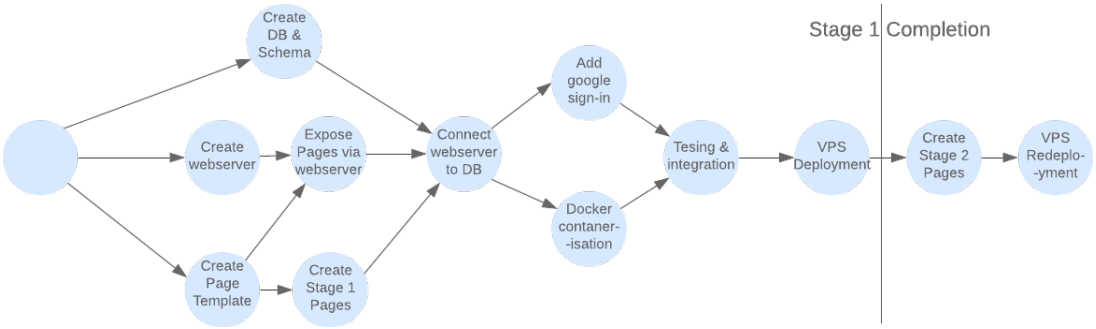


Figure 2: PERT Chart of project tasks

It is estimated that stage 1 will take up approximately 50% of development time, and be completed in mid-June

4.1 PERT Chart

[H] Figure 2 represents the below tasks and the dependencies between them.
Tasks

- Create database & schema.
- Create web-server.
- Create web-page template.
- Create stage 1 pages.
- Add Google sign-in.
- Docker containerisation.
- Testing & integration.
- VPS Deployment.
- Create stage 2 pages.
- VPS Redeployment.

5 Stage 1 Functional Requirements

The following are the core functional requirements for the first stage application, which will support the following users: coordinators and reviewers.

5.1 Coordinators

The following is the functionality to be made available to the coordinator by the Stage 1 system.

Identifier	Name	Description
FRC1	Coordinator Login	The coordinator can login using Google Sign-In
FRC2	Review Creation	The coordinator can create a new review
FRC3	Review Modification	The coordinator has the ongoing ability to specify and updates attributes of a review. These attributes include its title, the unit being reviewed, start date, planned end date and short description
FRC4	Reviewer Assignment	The coordinator can assign reviewers to a review by their email address
FRC5	Reviewer Removal	The coordinator can remove a reviewer from a review, and optionally the review that they have already completed
FRC6	Upload Materials	The coordinator can upload materials for the review
FRC7	Link to Materials	The coordinator can provide URL's to materials for the review
FRC8	Update Materials	The coordinator can update the description, title or content of materials
FRC9	Remove Materials	The coordinator can remove materials
FRC10	View Results	The coordinator can view the output of the review once it is complete

5.2 Reviewers

The following is the functionality to be made available to the reviewers by the Stage 1 system.

Identifier	Name	Description
FRR1	Reviewer Login	The reviewer can login using Google Sign-In
FRR2	View review projects	When logged in a reviewer can see the reviews they are assigned, their due dates and their progress
FRR3	Access and view materials	The reviewer is given access to the materials at the beginning of the review process and has ongoing access as they complete the review
FRR4	Affirm materials viewed	At the beginning of the process the review individually affirm their viewing of each material they have been provided
FRR5	Assign DL for EOC	For each EOC, assign a DL achieved for this unit. Descriptors for EOCs, DLs and IOAs will be displayed at the time of evaluation.
FRR6	Comment on EOC	For a given EOC, the reviewer has the opportunity to provide textual comment
FRR7	Give General Comments	At the end of the review process, the reviewer has the opportunity to give general comments
FRR8	Submit Review	After completing all steps the reviewer will submit their review

6 Stage 2 Functional Requirements

The following are the additional functional requirements for the second stage application, which will support for the following users: coordinators, reviewers and administrators. There is no additional functionality to be made available to the reviewer by the Stage 2 system.

6.1 Administrator Functional Requirements

The following is the functionality to be made available to the new "administrator" user class by the Stage 2 system.

Identifier	Name	Description
FRA1	Administrator Login	The administrator can login using Google Sign-In
FRA2	Add Coordinator	The administrator can add coordinators to the system.
FRA3	Remove Coordinator	The administrator can remove coordinators from the system
FRA4	Promote Coordinator	The administrator can make a user who is a coordinator an administrator
FRA5	Add Administrator	The administrator can add administrators to the system
FRA6	Remove Administrator	The administrator can remove administrators from the system
FRA7	Demote Administrator	The administrator can make a user who is an administrator a coordinator

6.2 Coordinator Functional Requirements

The following is the functionality to be made available to the coordinator by the Stage 2 system.

Identifier	Name	Description
FRC11	Collaborating Coordinators	The coordinator can add additional coordinators who have the same functionality available to them as the initial coordinator
FRC12	View Progress	The coordinator can view the overall progress of a review and the individual progress for each reviewer
FRC13	Generate Report	Once the review has been completed, the coordinator can generate a report detailing the review process, the results of the review and the materials used. This export should either be exportable as a Word Document
FRC14	Review Archiving	The coordinator can archive a review which doesn't have "active" status. Archived reviews are less prominently displayed on the portal, although still accessible
FRC15	Review Unarchiving	The coordinator can unarchive a previously archived review
FRC16	Custom EOCs	The coordinator can augment the base set of EA Elements of Competency.

FRC12, FRC14 and FRC15 are regarded as "nice-to-have" functionality rather than strict requirements

7 Non Functional Requirements

Identifier	Name	Description
NFR1	Extensibility	The system should be able to be easily extended and customised for new contexts
NFR2	Security	Modern security standards will be followed to ensure that confidential information (see Subsection **8.3**) is only accessible by the desired users. Furthermore, only authenticated and authorised users will be able to perform actions such as reviewing a unit, uploading materials or assigning reviewers
NFR3	Compatibility	The application will be compatible with recent versions of the major browsers (Safari, Chrome, Firefox and Edge) on Laptop and Desktop computers
NFR4	Performance	The page should have a size $<$ 500KB and a loading time $<$ 3 seconds on most desktop computing environments on standard NBN internet connections
NFR5	Recoverable	In the event of the web server or database server crashing, all stored data should be fully recoverable
NFR6	Portability and Deployability	The system should be able to be deployed across a wide range of server infrastructure. This will eliminate the need for additional development time if the system needs to be moved from it's original location or is adopted outside of UWA. This also simplifies the development process and prevents initial development from consuming UWA server resources.

8 Proposed Solution

8.1 Core Technologies

It is proposed that this solution will be built on the MEAN stack, consisting of MongoDB, ExpressJs, Angular and NodeJs. This comprehensive stack exclusively utilises JavaScript, allowing for a greater integration between components and therefore reduced development time & costs. Google sign in will be used for authentication, and the system will be built as a docker container connecting to a MongoDB Atlas database.

The licenses for the software of the MEAN stack (SSPL, MIT License, MIT and MIT respectively) allow for the stack to be used in this context.

8.1.1 MongoDB

MongoDB is a noSQL database solution that is efficient and flexible with minimal overhead. It would fulfil all data storage requirements of the system.

8.1.2 NodeJS

NodeJS is a common technology used to build the backend of the web applications. It will be used as the interface between the website and the database, appropriately delivering webpages.

8.1.3 Angular

Angular is a popular frontend technology to create easily usable websites. As it is a framework, it is considered a complete solution to creating the user-facing portion of the system.

8.1.4 Docker

To satisfy NFR6, the system must have the smallest number of dependencies and requirements. As a result, the backend webserver will be built as a docker image. This will mean the only requirement to run the webserver on any machine is docker

8.1.5 Google Sign-In

Google Sign-In will be used as the sole authentication method for this project. This has the benefit of bypassing pheme, allowing reviewers to avoid creating an account or refreshing expired passwords. Google is practically universally adopted, so it is expected that all reviewers will have at least one Google account.

Google Sign-In uses the OAuth2 protocol and OIDC, the industry standards for user authentication and authorisation. Implementing Google Sign-In is achieved by interfacing with popular and well-maintained libraries of code. It completely avoids storing user passwords. As a result, Google Sign-In simplifies and strengthens the attainment of NFR2(security)

8.1.6 Code style and quality

Written code, especially javascript, will conform to the applicable "Google Style Guide", as found on `https://google.github.io/styleguide/`.

Written code will be reviewed in accordance to the System Health Lab code-review procedures

8.1.7 Code storage and development control

The Git version control system will be used, using the remote UWA System Health Lab organisational GitHub

8.2 Screenshots

These screenshots represent one possible appearance of the system after the completion of development stage 2. However these designs will continually be improved and tweaked during the development process, and primarily serves to illustrate the overall feel of the app alongside prototyping page flow.

The UI design for administrators can be found here:
`https://www.figma.com/proto/71COIKoUM5Y1YZuQyO9zS4/IAP?node-id=57%3A262&scaling=scale-down`

The UI design for coordinators can be found here:
`https://www.figma.com/proto/71COIKoUM5Y1YZuQyO9zS4/IAP?node-id=57%3A262&scaling=scale-down`

The UI design for reviewers can be found here:
`https://www.figma.com/proto/71COIKoUM5Y1YZuQyO9zS4/IAP?node-id=4%3A3&scaling=scale-down`

Select screenshots can be found in Appendix B

8.3 Information management and Atlas

The materials prepared for the review process, the results of the review process and the information of all users will all be treated as sensitive information. The use of Google Sign-In will decrease the sensitive information which the application stores as the system will not need to manage the secure storage of passwords.

The cloud database service MongoDB Atlas will be used to store all backend information. Utilising this service will drastically simplify the development process. Atlas offers three cloud providers — AWS, GCP and Azure — which actually provides the cloud software. Based on the rationale in Appendix **A**, AWS was selected as the cloud provider. The ap-southeast-2 availability zone will be used, which will ensure that all system data is stored in Australia.

8.4 Execution Team

The development of the system will be performed by **Marcus Handley**. **Caitlin Woods** will provide advice on technology choices and implementation and will run code reviews. **Professor Melinda Hodkiewicz** is the academic liaison.

Marcus Handley's linkedin can be found here:
`https://www.linkedin.com/in/marcus-handley-a2a6b1179`

Caitlin Wood's linkedin can be found here:
`https://www.linkedin.com/in/caitlin-woods/`

Professor Melinda Hodkiewicz is a professor of mechanical engineering at UWA.

Appendix A Cloud provider cost comparison for Mongo DB Atlas

Mongo DB Atlas offers 3 cloud service provided: Amazon Web Services (AWS), Google Cloud Platform (GCP) and Azure each with different minimum cluster sizes, availability regions and cost models. This appendix lays out the justification of the **recommended cloud service provider — AWS**.

Atlas offers a free M0 cluster which may be appropriate for initial development but is not suitable for production use due to it not being offered in any Australian Access Zones and lack of backup options.

The following calculation uses pricing for the cheapest Australian availability zones — AWS: ap-southeast-2, GCP: australia-southeast1, Azure: australiaeast.

A.1 Data transfer and storage requirements

The recent MECH5552 had approximately 24MB of documents uploaded. The average completed review would contain less than 5KB of data. As a result, it it estimated that one review would require 25MB of data storage. The storage requirements of other data (e.g. users of system) are likely insignificant. As the webserver will employ strategies such as the caching of static documents to avoid unnecessarily data-transport costs from Atlas. As a result, static documents will only be fetched once per instance of the webserver.

It is estimated that the webserver will be redeployed at most once a week, once in production, although this estimate is highly dependent on stability. Therefore data storage and transfer requirements can be estimated as

- Storage Requirements: 25MB / review
- Transfer Requirements: 100 MB / active review / per month

Below are three possible scenarios and their associated data requirements
Development: 2 active reviews and 5 times data transfer due to active system development.
Necessitates 50MB of storage and 1GB of the data transfer / month
Light adoption: 5 active reviews.
Necessitates 125MB of storage and 0.5 GB of data transfer / month
Heavy adoption: 10 active reviews and 10 inactive (i.e. completed) reviews.
Necessitates 500MB of storage and 1GB of data transfer / month

A.2 Choice of service provider

With AWS as a cloud service provider, the minimum cluster size is M2 providing 2GB storage and Shared RAM costing 9 USD per month. With either GCP or Azure as a selected cloud service provider the minimum cluster size is M10 providing 2GB RAM and 32GB storage costing 90 USD per month. All three usage scenarios would have their storage needs satisfied by the M2 cluster. As only AWS offers this small a cluster size, the monthly storage cost of AWS is a tenth of that of either GCP and Azure, saving 80 USD per month.

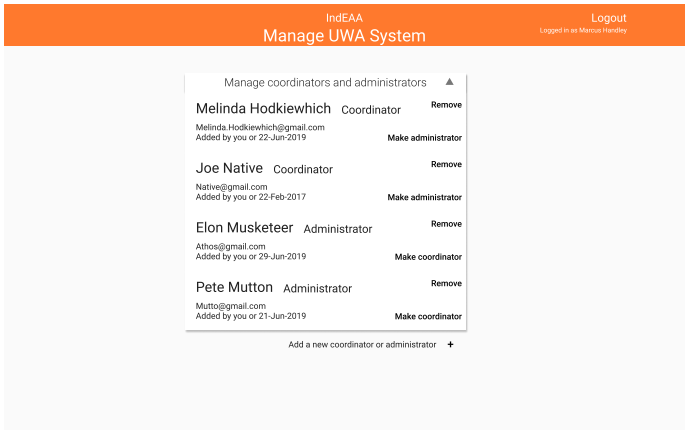
Data transfer costs vary between provider and nature of transfer, from 1 to 19 US cents per GB. The monthly cost difference for transfer between services at the estimated 1GB / month is more than 1 and a half orders of magnitude below the $80 USD saving which AWS provides.

There are various backup data services within a similar price range to the above data transfer costs.

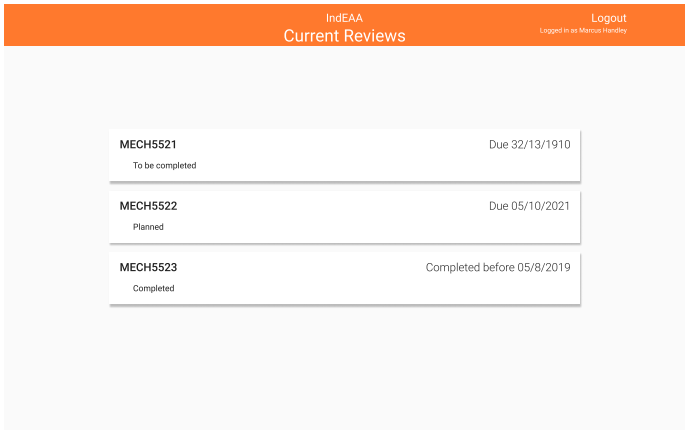
As a result of the above analysis, AWS is the recommended cloud service provider to be used with MongoDB Atlas due to its reduced costs.

Appendix B Select UI Screenshots

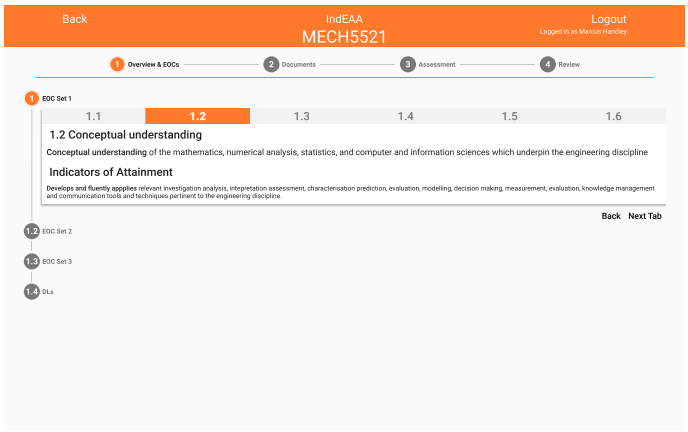
Designs of key UI screens are below. A more completed UI design with prototype interactions can be found in the links specified in subsection 8.2



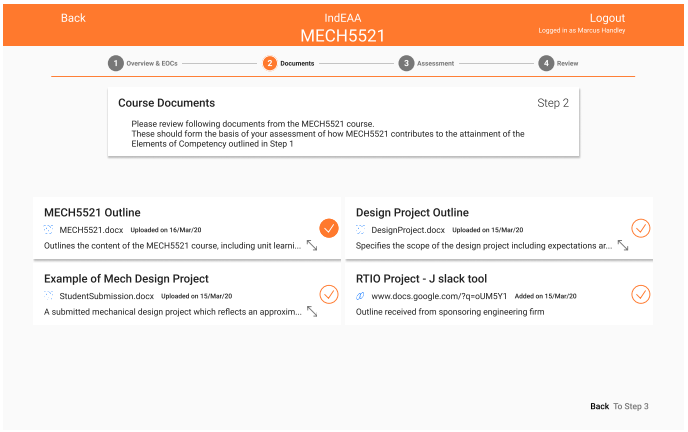
(a) Admin landing page



(b) Reviewer landing page

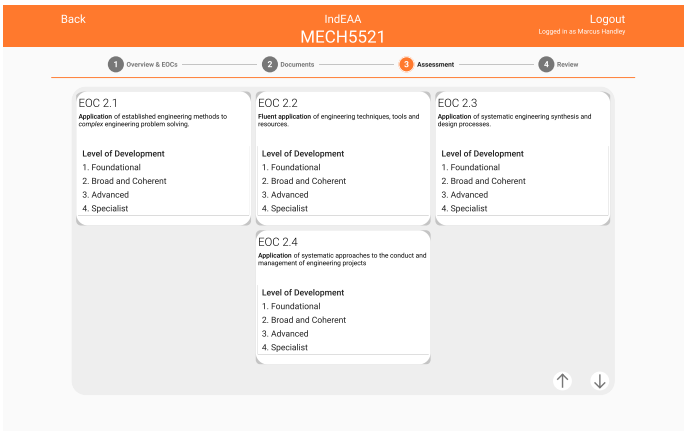


(d) Step 1 of review process: Development Levels



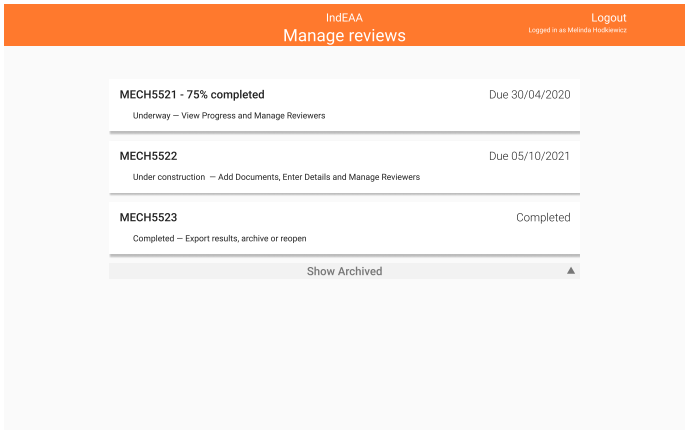
(e) Step 2 of review process: Documents

(c) Step 1 of review process: Elements of Competency

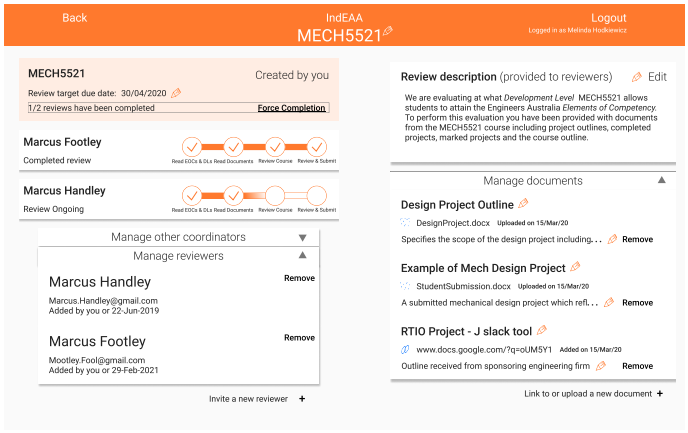


(f) Step 3 of review process: Evaluation

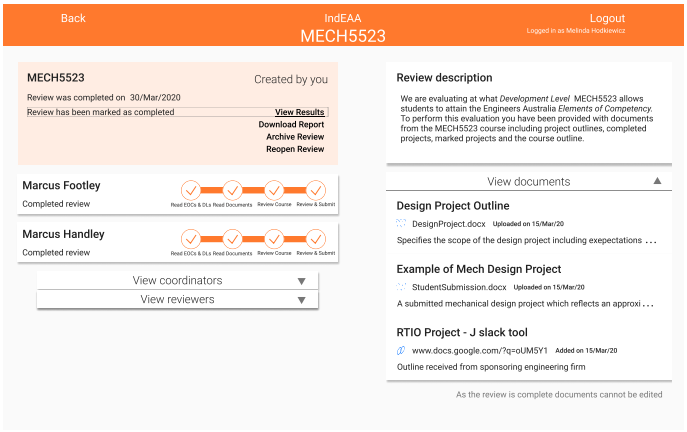
Figure 3: Screenshots



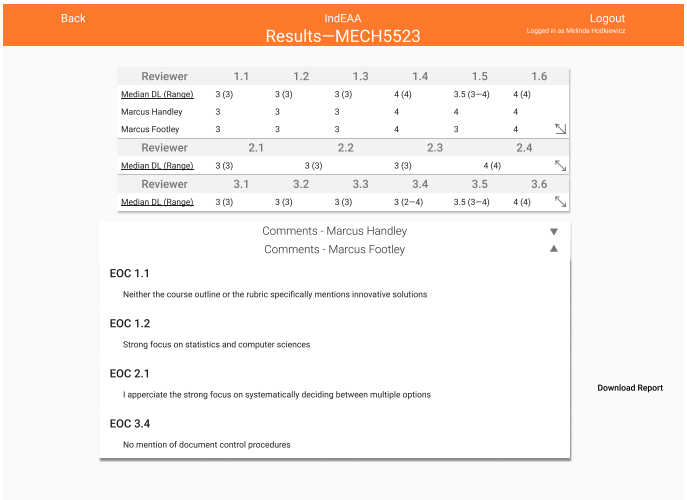
(a) Coordinator landing page



(b) Ongoing review (coordinator's view)



(c) Complete review (coordinator's view)



(d) Results of review (coordinator's view

Figure 4: Screenshots(continued)