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UKCDR V2: Specification

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Introduction

The purpose of this document is to provide an overview of the different functionalities that would form the core of a system based on an analysis of the various use cases collected in the framework of the UKCDR specification gathering initiative. Data was collected from a series of academic assessor groups so as to elicit the core functionalities necessary to support current, minimum best practice, assessment activities. UKCDR takes a particular interest in high stakes assessment, where the items, examinations and associated data need to be kept secure.

Assessment processes, particularly those of a high stakes nature, are in one sense inherently complex, and in another sense, remarkably similar across contexts. As such, the intent is to produce a best practice set of common requirements which will be immediately useful to academic groups who wish to engage, effectively, with the software development community.

Overall, it is hoped that the documentation produced under UKCDR V2 will be a stimulus for the development of pedagogically sound item banking and associated assessment technologies.

This final version of the specification has been developed on the basis of the feedback gathered after submission to UKCDR partners.

Methodology

In order to provide a generic and concise set of features and functionalities to best reflect the core needs of the UKCDR contributing communities the process of producing the material enclosed in this document has been divided into two parts:

- Use case data gathering and validation
- Requirement elicitation and refinement

The diagram in figure 1 displays how these methods have been used to create the functional requirements:

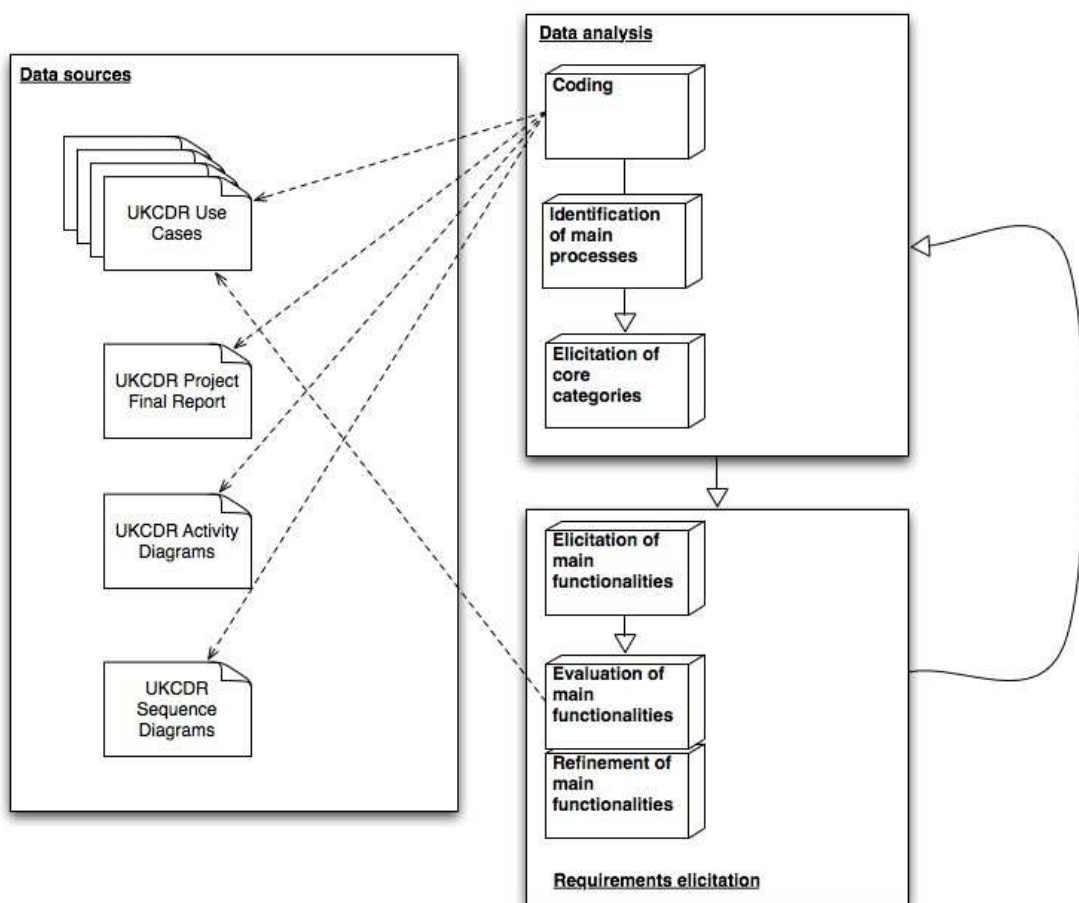


Fig.1. Data gathering and requirements elicitation processes for UKCDR V2

A qualitative data analysis approach has been chosen to ensure the various activities described in the use case documentation are meaningfully reflected in the functional requirements, with each subsequent requirement taking on the appropriate saliency.

According to this approach, as recommended by Charmaz (2003), answers have been sought to a set of questions as shown in figure 2:

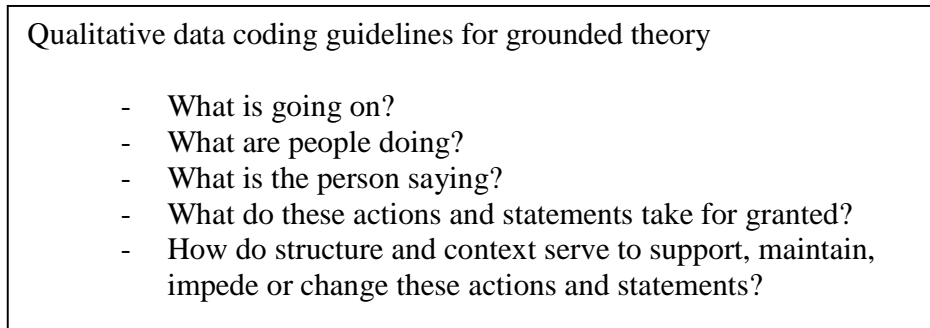


Fig.2. Qualitative data coding guidelines for grounded theory, taken from Charmaz (2003, p.94-95)

To ensure maximum effectiveness of the specification for each of the UKCDR contributors and the wider contributing communities, the functional requirements are expressed here in two ways:

- Requirements in lay terms
- Technical requirements analysis

The requirements, as expressed in lay terms, are designed for our various academic community audiences, to engage and connect with the specific needs of examiners and examining groups. Whilst these requirements offer contributors the means to liaise with technical providers to discuss and arrange technology to suit individual needs, the technical requirements analysis offers an opportunity for direct, meaningful communications with developers.

Pact analysis

A PACT allows requirements gathering teams to effectively grasp significant issues in system design:

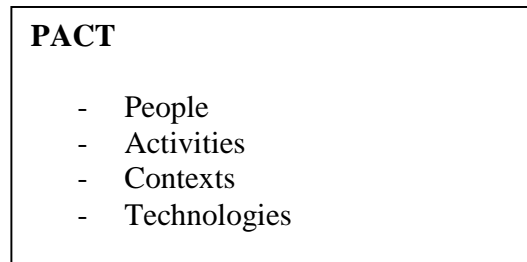


Fig.3.PACT analysis, from Benyon et al;. (2005)

People

It is appropriate to take into account the range of different people and roles involved in the assessment process, through from exam planning, item generation and quality assurance to examination marking and feedback, followed by post examination item and examination scrutiny. The various roles involved can be very different and each must be reflected in the requirements design.

Activities

The tasks and activities that must, or can, take place in any assessment lifecycle are numerous and diverse. The process of managing these tasks and activities is in itself a complex process which is important to reflect in the specification.

Context

Whilst a common set of requirements is intended in the final specification, it is important that context factors are not compromised. By actively searching for differences across the corpus of use cases and cross matching the proposed underlying commonalities contextual factors are allowed to shape and determine the specification. In the first version of UKCDR it was found that enormous amounts of common ground existed across different contexts and the same finding has so far been found in the process of creating UKCDR V2.

Technology

The issue of technology has become increasingly important in the context of assessment, and particularly in the framework of exam delivery, where exam papers are created and delivered electronically as opposed to the 'traditional' exam paper format. Environmental issues and the prevailing political inclination to create efficiencies have created a sustained interest in 'all digital' assessment solutions, particularly in examination delivery. However, the rate of technological change, together with the risk of making the leap to an untested mode of working, as well as the often prohibitive costs of making an initial purchase, has left some assessor groups reluctant to make the switch. It is therefore important that within this specification, there is no predetermined technology option, indeed there is no intent to suggest that one technology will suit all, rather that needs should dictate requirements, which should then allow individuals and groups to find the best fitting technology.

Data analysis: themes, categories and processes

UKCDR V1 core processes

The first iteration of UKCDR was the starting point for this work. The UKCDR 2007 report detailed six different 'core processes' as defined from the collected use cases (UKCDR Final report, p. 15):

- Item development
- Quality assurance
- Item storage and selection
- Exam delivery
- Results analysis

The core processes were a culmination of work with contributors to validate use cases, and similarly to validate the elicited requirements. The requirements were represented in lay terms as a list, and in activity diagrams. These were subject to a final review by technical and academic commentators at a final validation workshop (UKCDR Final Report, p. 16).

Core themes in UKCDR V2

Taken together, the use cases from the previous iteration of UKCDR, and those newly gathered here, suggest a simpler, more streamlined common set of needs. Indeed, the coding process of the various UKCDR use case made two categories emerge quite clearly:

- **Item development**
The creation, indexing and quality assurance of the various items that will be used in the framework of exams
- **Item use**
The use of items in the framework of exams, and the collection of data related to this use. This theme could be seen as more streamlined when compared to the item development theme, as a clear timeline can be

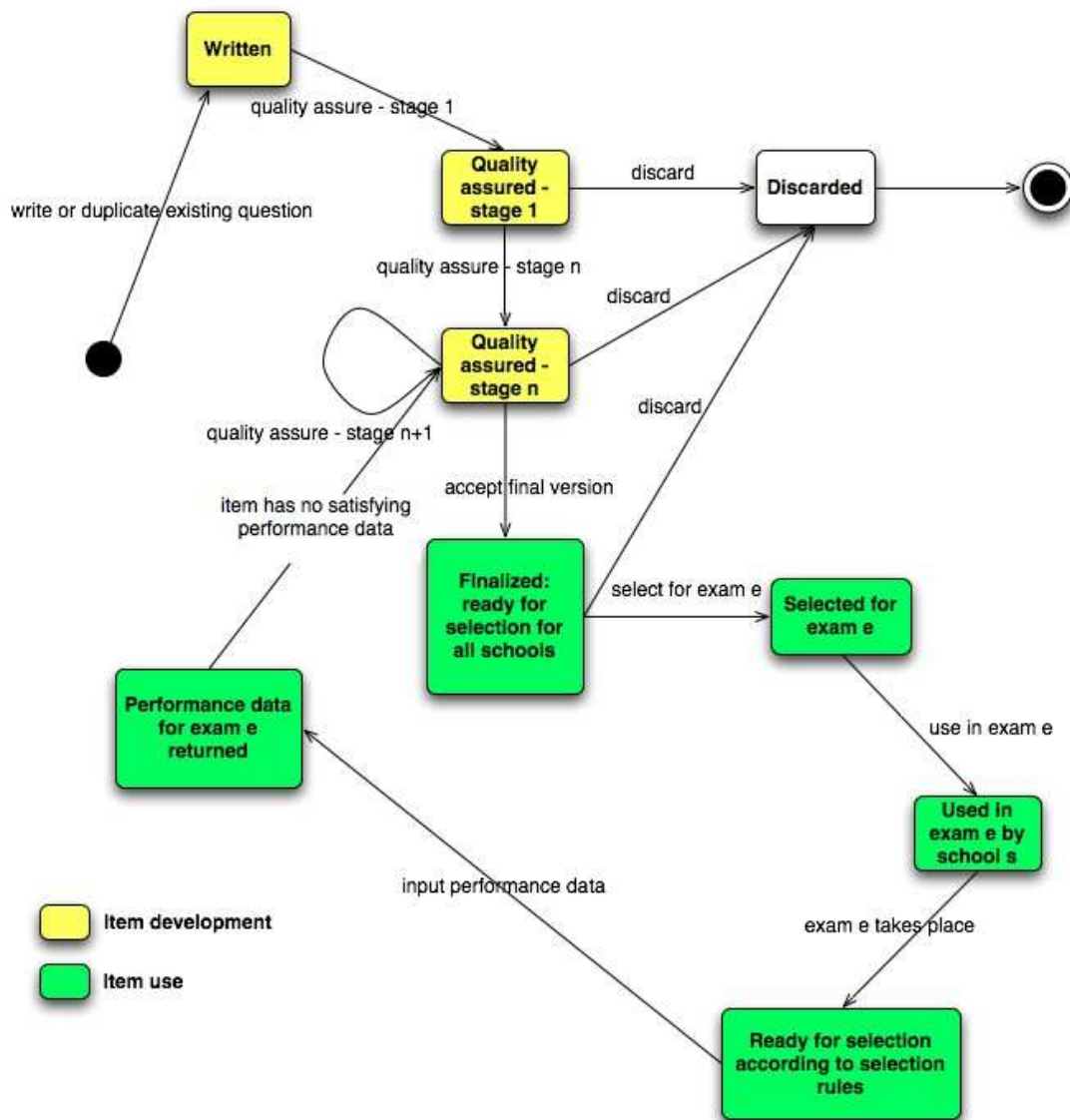


Fig.4. The item lifecycle

The item lifecycle proposed on fig. 4 illustrates the particularly intertwined nature of the relationships between item development and item use. Indeed, it can be observed that in some cases, item development can originate from a need identified during the item use process. However, another scenario could be that the need for a particular type of item could be identified in the framework of the review of a particular organization's item pool, with the help of the classification metadata being stored against each item. Thus, the centrality of the item quality assurance process needs to be explicitly taken into account in the requirement elicitation process.

UKCDR V2 core processes

One of the most salient characteristics that emerge from the set of UKCDR use cases is the lack of a linear temporal relationship between these processes, as presented on *fig. 4*. Thus, the core processes emerging from an analysis of the various UKCDR use cases could be decomposed as follows:

Item generation

The authoring and elaboration of items is performed by various users having different roles within the framework of the item quality assurance process, making appropriate contributions and corrections to the items until they are considered ready to be selected for an exam. Secondary and tertiary processes revolving around this process are item quality management, item classification metadata management. Accordingly, the lifecycle of an item in the framework of the proposed system could be understood as illustrated by *fig. 4*, where the item generation process can be seen as supported in some cases by the management of item development and item quality assurance workflows.

Item selection

This process covers the selection of particular items for particular exams, and the creation and management of exam blueprints. The item selection process is in many cases the point of origin for the elicitation of particular item needs, in conjunction with the analysis of item classification and performance data, and can therefore trigger item generation activity, as illustrated by the temporal relationship between the item selection and item generation processes illustrated on *fig. 5*. Even though it could be supposed that the items used in the framework of the item selection process have been through the quality assurance process, the quality of the items can be further evaluated in the framework of the item selection process, as some use cases actually present signs of item quality assurance activity during item selection.

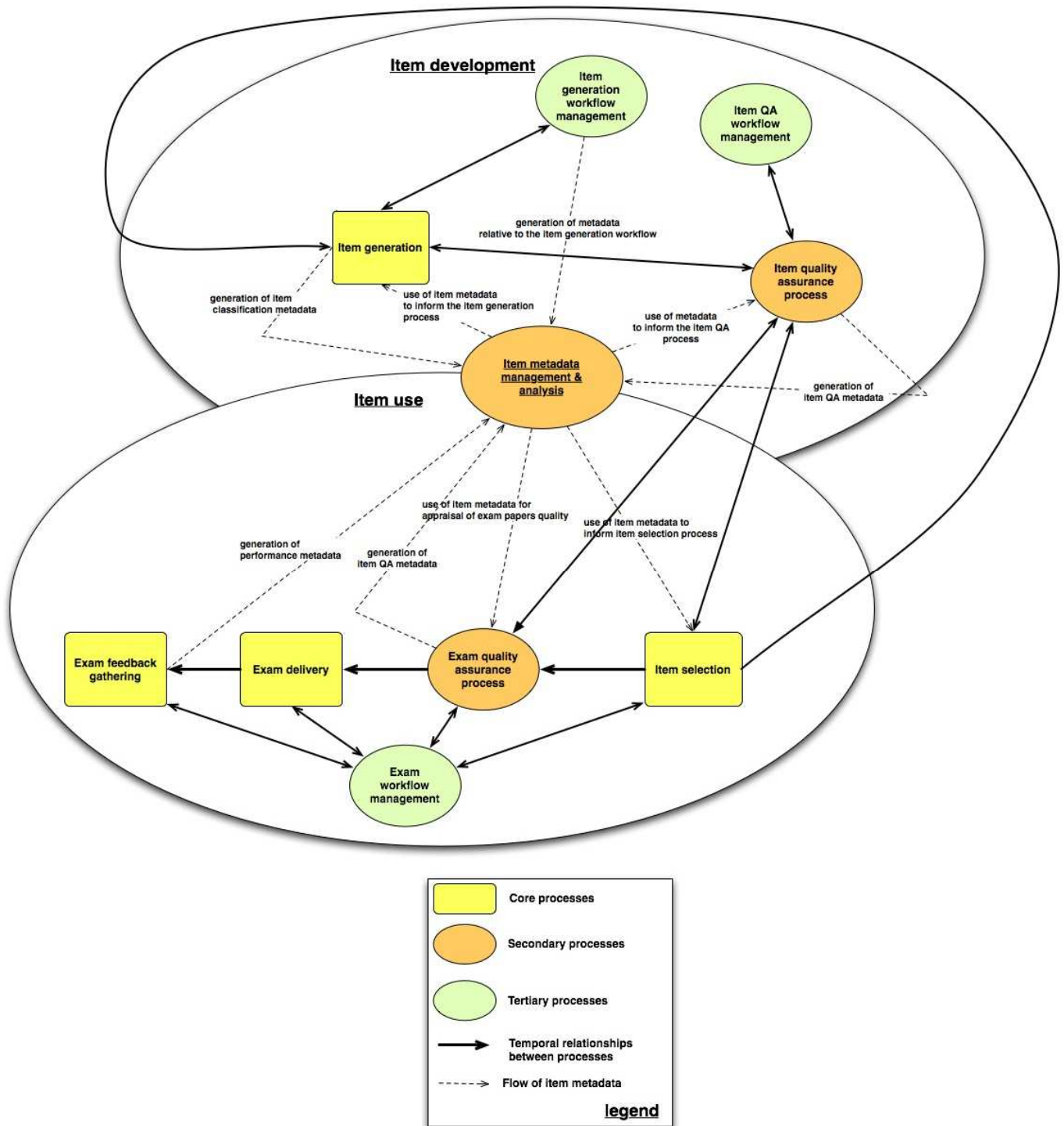


Fig.5. The interplay of the various processes identified in the UKCDR use cases

As it can be seen on *fig. 5*, a feature that tends to appear from the use cases is the central role of metadata as a support for most of the processes both for item development and item use. Indeed, items could be seen as particularly rich in various types of information

used to facilitate their classification and to support the various quality assurance processes involved in item development and use.

Exam delivery

The delivery of exams from their 'collection of items' form to a final exam paper is the responsibility of one or several teams within each medical school, such as for instance a 'board of examiners', or an 'exams working party'. The exam delivery process could be seen as closely related to other processes such as the exam quality assurance process, and can be managed in the framework of the exam workflow management process, as illustrated in *fig. 5*.

Exam feedback data gathering

The gathering of performance data for the items being used during exams is the final stage of the 'item use' theme, and entails the collection of performance data against candidates, exams, and items. This performance metadata is then used to inform other processes in the item lifecycle, such as item generation or item selection. The sensitive nature of some of this data entails the need for compartmentalisation and anonymisation of this performance metadata.

Secondary processes

Around the four core processes presented in the previous section revolve two types of secondary processes:

- **Item Metadata management and analysis**
As illustrated by *fig. 4*, item metadata is generated and used at each step of the item lifecycle.
- **Quality assurance processes**
Two quality assurance processes can be identified.
 - Item quality assurance
 - Exam quality assurance

As illustrated by *fig. 5*, the input and analysis of data surrounding the items available in the proposed system would support the item selection and item generation processes. These could be decomposed in four further subcategories:

Classification metadata

Classification metadata is mostly generated in the framework of the item generation process. Its primary objective is to inform the item selection process.

“name, block, learning outcome, usage, author, date written” (Contribution A)

“(…) a MS Word template that captures a unique ID, author name and speciality, date of authorship, question speciality, topic i.e. respiratory, group i.e. diagnosis, and diagnostic classification. There is a tree of diagnostic classifications which all have unique codes, similar to MeSH terms” (Contribution B).

Item quality assurance metadata

Items go through two types of quality assurance processes, namely the item quality assurance process itself, as well as the exam/paper quality assurance process. The status of items and of exams papers in regards to the specific quality assurance processes taking place in each body takes the form of metadata attached to both items and exam objects.

Item performance metadata

The use of performance metadata could be seen as rather consistent across the various use cases. Similarly, the same type of data is collected across various use cases, as illustrated by the quotes presented below:

“(…) facility, % classification” (HYMS use cases, results analysis)

“point bi-serial, discrimination index, facility value, decile and quintile response data and IRT” (Contribution C).

Different levels of depth in the item performance data (analysis can also be done at candidate level and various demographic data is captured)

“This allows a number of statistics to be generated and stored against the exam, question, and student” (Contribution D).

Item performance metadata has a central role for item selection and item quality assurance

“any item that perform very well or very poorly are flagged and this information is put in front of the Exam Board prior to candidates being given their score”. Items can be removed from exams retrospectively” (Contribution E).

“This also enables us to review the performance of our items, test specification and grading rules. This is also fed back to item writers and used to flag poorly performing questions” (Contribution G).

Workflow metadata

Items are produced in the framework of various processes which can be seen as rather particular to each of the bodies represented in the use cases. The management of these processes within the system implies the use of metadata relative to them, allowing users to situate these items within the workflow management process.

Tertiary processes

These processes entail the management of objects distinct from items and item metadata.

Item generation workflow management

Organisations such as UMAP keep track of the events during which items are being authored and reviewed. Metadata is therefore attached to items accordingly, and is used to improve the organisation's performance in terms of quality assurance and coverage.

Exam workflow management

Although exam management could be seen as a rather generic process, exams can be managed differently by the various organizations involved in the UKCDR initiative. Indeed, organizations have a choice whereas they want to handle the whole exam organization and delivery process through the system, or to delegate such a task to a tier workflow management program.

Variation between participants

Although differences appear between the different use cases submitted by the various bodies that participated to the UKCDR initiative, these could be seen as rather minor. Indeed, most of the differences that have been noticed could be divided in four broad categories:

- differences in the metadata being stored against items
- differences in the number of steps and users involved in the quality assurance processes
- differences of format for the exam delivery process
- differences in terms of workflow management needs

However, one particular participant, UMAP, stands out from this rather homogenous set of use case, due to the specificity of its processes. Indeed, UMAP's particular needs in terms of quality assurance and workflow processes management, as well as the fact that this organisation is not directly involved with exam delivery, but delegates this task to its numerous partners lead to a widening of the scope of the specifications presented in the second part of this report.

Requirements

This section presents the actual requirements for a system that would provide support for the several processes described in the first part of this report. Different roles have been identified, to which particular functionalities have been attributed. The roles have been divided in three main categories, following the core themes that emerged from the data analysis.

- system administration
- item development
- item use

The aim of this first set of functionalities is to provide generic support for the various processes uncovered during the data analysis process. They should therefore not be seen as exhaustive and definitive sets of functionalities but as design guidelines.

System administration

Introduction

System administration regroups all the functionalities that are necessary in order to configure the system for a particular use. These various functionalities have been attributed to various administrator roles, each responsible for one aspect of the customisation of the system for the needs of a particular organisation.

Roles

Five roles have been identified in the framework of system administration:

- **User administrator**
Responsible for creating users and attributing roles to these
- **Metadata structure administrator**
Responsible for creating the structure of the metadata being stored against items
- **Item QA administrator**
Responsible for implementing the organisation's item quality assurance process in the system
- **Exam QA administrator**
Responsible for implementing the organisation's exam quality assurance process in the system
- **Item generation workflow administrator**
Responsible for implementing the organisation's workflow for item generation management
- **Exam workflow administrator**
Responsible for implementing the organisation's workflow for exam management

Functionalities

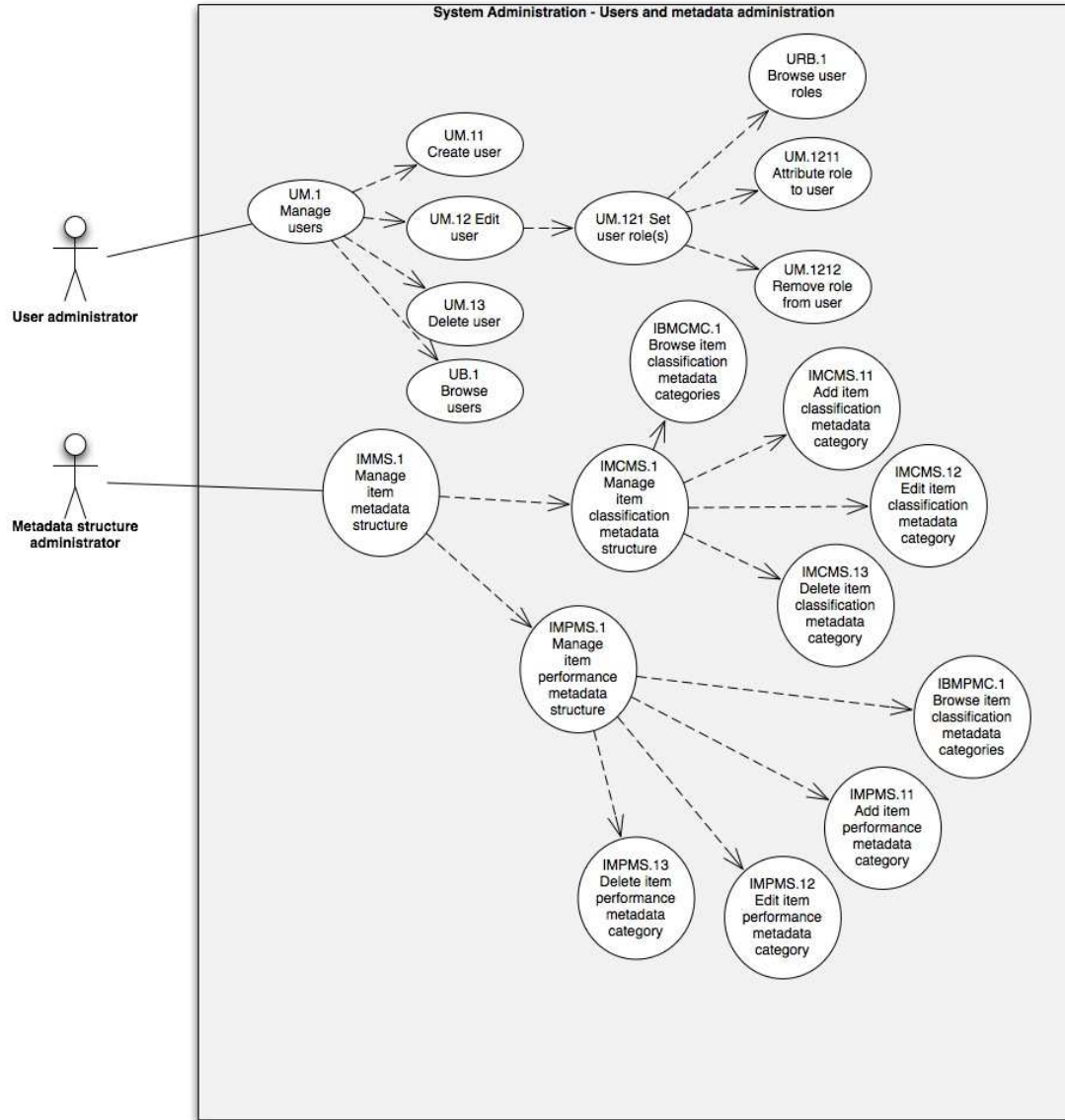


Fig.6. Use case diagram: System administration: users and metadata administration

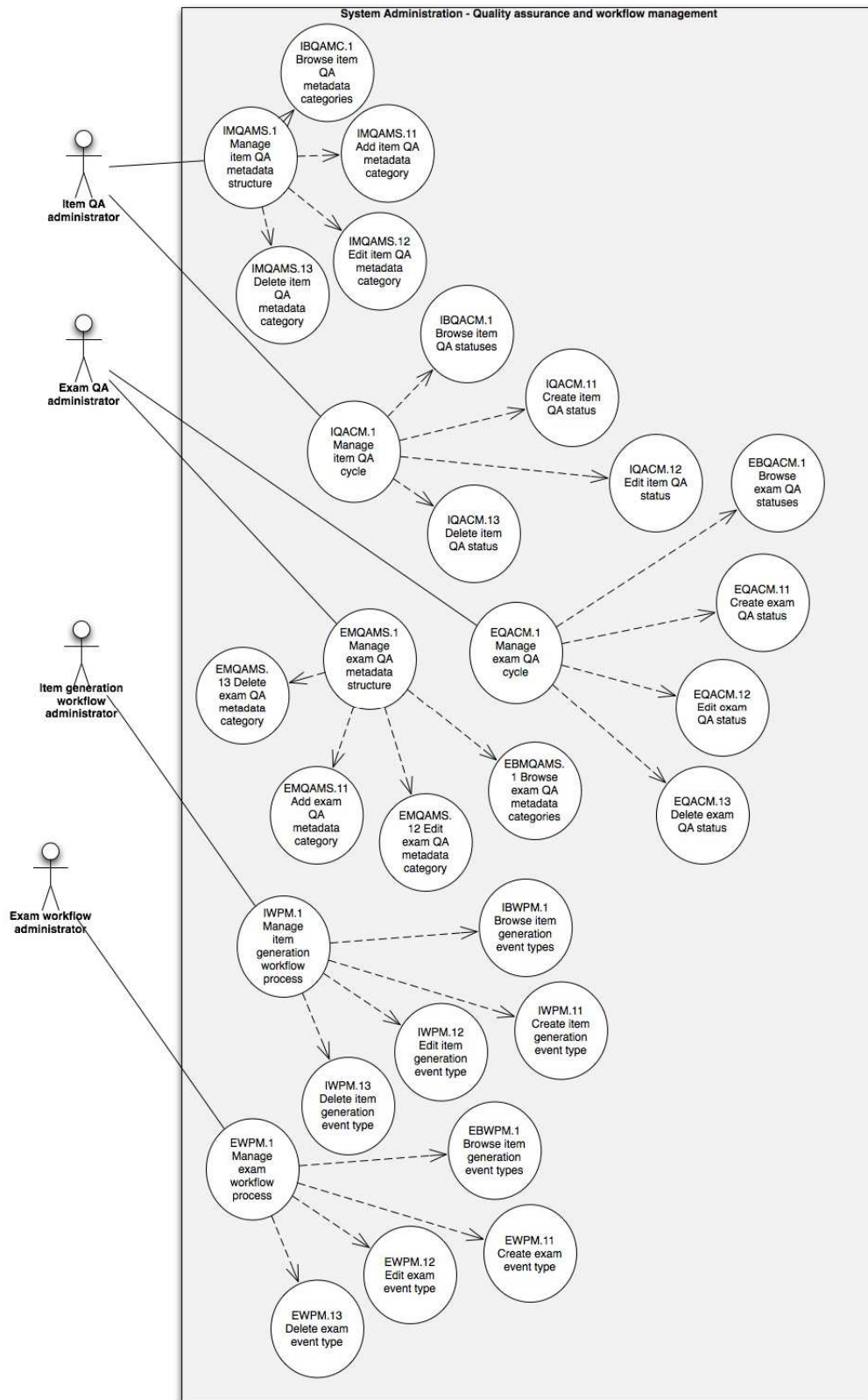


Fig.7 Use case diagram: Administration: quality assurance and workflow management

User administrator

- ***UM.1 Manage users***
 - UB.1 Browse users
 - UM.11 Create user
 - UM.12 Edit user
 - UM.121 Set user role(s)
 - URB.1 Browse user roles
 - UM.1211 Attribute role to user
 - UM.1212 Remove role from user
 - UM.13 Delete user

Metadata structure administrator

- ***IMMS.1 Manage item metadata structure***
 - IMCMS.1 Manage item classification metadata structure
 - IBMCMC.1 Browse item classification metadata categories
 - IMCMS.11 Add item classification metadata category
 - IMCMS.12 Edit item classification metadata category
 - IMCMS.13 Delete item classification metadata category
 - IMPMS.1 Manage item performance metadata structure
 - IBMPMC.1 Browse item performance metadata categories
 - IMPMS.11 Add item performance metadata category
 - IMPMS.12 Edit item performance metadata category
 - IMPMS.13 Delete item performance metadata category

Item QA administrator

- ***IMQAMS.1 Manage item QA metadata structure***
 - IBQAMS.1 Browse item QA metadata categories
 - IMQAMS.11 Add item QA metadata category
 - IMQAMS.12 Edit item QA metadata category
 - IMQAMS.13 Delete item QA metadata category

- ***IQACM.1 Manage item QA cycle***
 - IBQACM.1 Browse item QA statuses
 - IQACM.11 Create item QA status
 - IQACM.12 Edit item QA status
 - IQACM.13 Delete item QA status

Exam QA administrator

- ***EMQAMS.1 Manage exam QA metadata structure***
 - EBMQAMS.1 Browse exam QA metadata categories
 - EMQAMS.11 Add exam QA metadata category
 - EMQAMS.12 Edit exam QA metadata category
 - EMQAMS.13 Delete exam QA metadata category

- ***IQACM.1 Manage exam QA cycle***
 - IBQACM.1 Browse exam QA statuses
 - IQACM.11 Create exam QA status
 - IQACM.12 Edit exam QA status
 - IQACM.13 Delete exam QA status

Item generation workflow administrator

- ***IWPM.1 Manage item generation workflow process***
 - IBWPM.1 Browse item generation event types
 - IWPM.11 Create item generation event type
 - IWPM.12 Edit item generation event type
 - IWPM.13 Delete item generation event type

Exam workflow administrator

- ***EWPM.1 Manage exam workflow process***
 - IBWPM.1 Browse exam workflow event types
 - IWPM.11 Create exam workflow event type
 - IWPM.12 Edit exam workflow event type
 - IWPM.13 Delete exam workflow event type

Item development

Introduction

This area of functionality is concerned with the creation, edition, and quality assurance of items. The writing of questions can be triggered in the framework of the item selection process where “insufficient coverage of specific areas in the bank” is detected, or be part of a process like it is the case for UMAP, where items are written in the framework of question writing.

Items can feature images and special characters, which needs to be taken into account by the system. The use of letters from the Greek alphabet or of mathematical notation in the item would need to be catered by the system, as well as the possibility of the inclusion of pictures in the items.

Roles

Five roles have been identified in the framework of item development:

- **Item generation workflow manager**
Responsible for managing the events surrounding the item generation process
- **Item author**
Responsible for writing and editing items
- **Item QA officer**
Responsible for quality assuring items
- **Item QA workflow manager**
Responsible for managing the events surrounding the item QA process
- **Reporter**
Responsible for reporting on items

Functionalities

The various functionalities of the proposed system have been decomposed and attributed to each of the roles that have been identified in the previous section of this report.

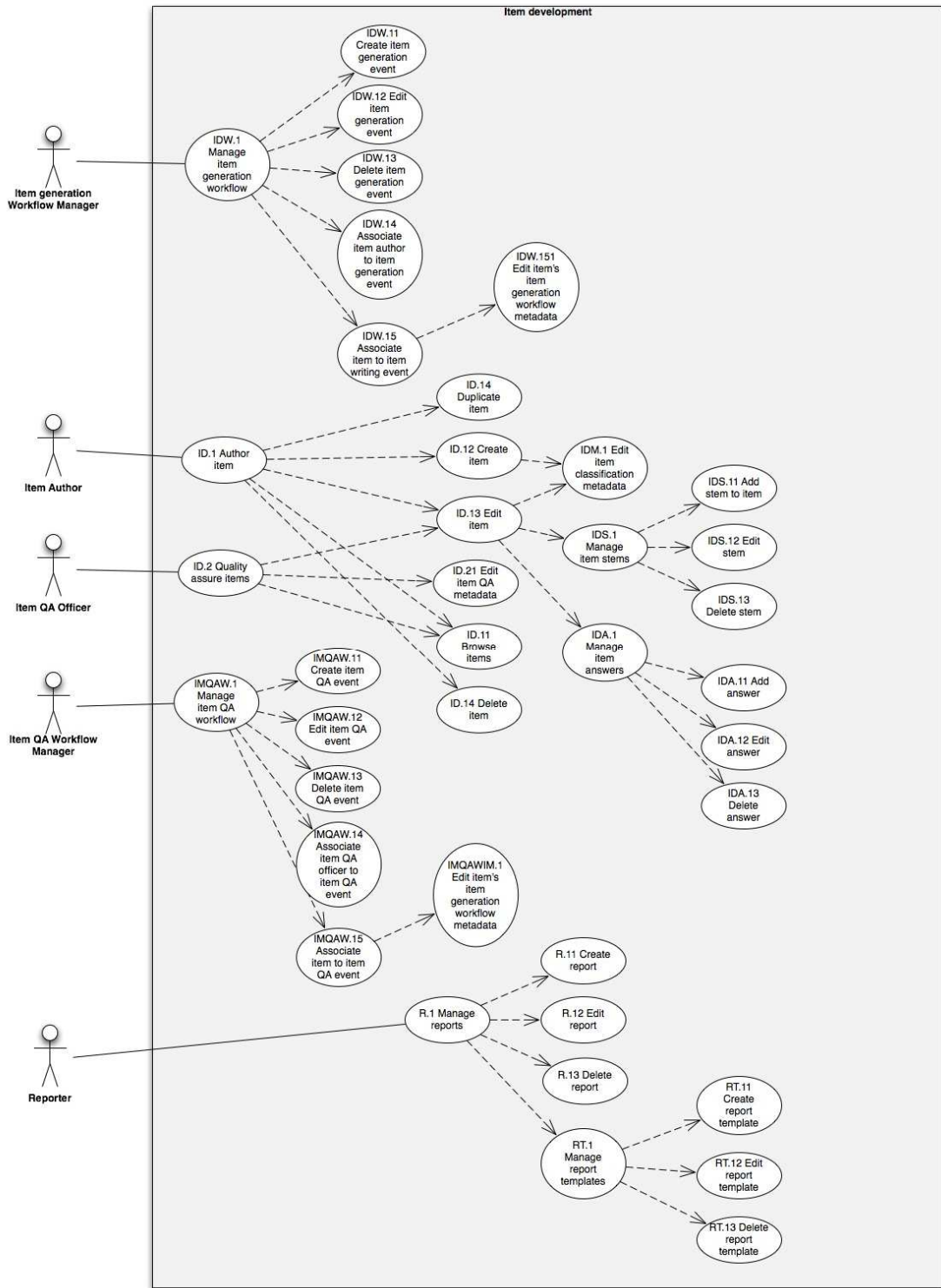


Fig.8. Use case diagram: Item development

Item generation workflow manager

- ***IDW.1 Manage item generation workflow***
 - IDW.11 Create item generation event
 - IDW.12 Edit item generation event
 - IDW.13 Delete item generation event
 - IDW.14 Associate item author to item generation event
 - IDW.15 Associate item to item writing event
 - IDW.151 Edit item's item generation workflow metadata

Item author

- ***ID.1 Author item***
 - ID.11 Browse items
 - ID.12 Create items
 - ID.13 Edit item
 - IDM.1 Edit item classification metadata
 - IDS.1 Manage item stems
 - IDS.11 Add stem to item
 - IDS.12 Edit stem
 - IDS.13 Delete stem
 - IDA.1 Manage item answers
 - IDA.11 Add answer
 - IDA.12 Edit answer
 - IDA.13 Delete answer
 - ID.14 Delete item

Item QA Officer

- ***ID.2 Quality assure items***
 - ID.11 Browse items
 - ID.13 Edit item
 - IDM.1 Edit item classification metadata
 - IDS.1 Manage item stems
 - IDS.11 Add stem to item
 - IDS.12 Edit stem
 - IDS.13 Delete stem
 - IDA.1 Manage item answers
 - IDA.11 Add answer
 - IDA.12 Edit answer
 - IDA.13 Delete answer
 - ID.21 Edit item QA metadata

Item QA workflow manager

- ***IMQAW.1 Manage item QA workflow***
 - IMQAW.11 Create item QA event
 - IMQAW.12 Edit item QA event
 - IMQAW.13 Delete item QA event
 - IMQAW.14 Associate item QA officer to item QA event
 - IMQAW.15 Associate item to item QA event
 - IMQAWIM.1 Edit item's item generation workflow metadata

Reporter

- ***R.1 Manage reports***
 - R.11 Create report
 - R.12 Edit report
 - R.13 Delete report
 - RT.1 Manage report templates
 - RT.11 Create report template
 - RT.12 Edit report template
 - RT.13 Delete report template

Item use

Introduction

The functionalities presented in this section revolve around the selection of particular items for exams and could be seen as forming one of the main features of the proposed system. The term 'exam' will be used here to represent the particular selection of items composing an exam paper. The main aspects of this functionality could be decomposed as follows:

- **Handling of the exam management process**
The particular processes involved in the management of exams would need to be implemented by the system in a rather exhaustive manner. Indeed, the item selection process could be seen as heavily dependant on statistical data that can only be provided if the system holds precise information about the use of any item in the bank, as well as statistical data, such as for instance the level of difficulty of a particular question, or the performance data associated with each item.
- **Statistical and reporting tools for supporting the item selection process**
The selection of items for a particular exam is performed according to a model referred to as a 'blueprint'. Furthermore, statistical data, such as, for instance, the use of items in precedent exams, or their degree of difficulty is used in the framework of the item selection process. In the case of certain schools, exam papers are rotated for each cohort with approximately 20% of the paper being changed year on year.
- **Exam quality assurance process**
A particular exam goes through various stages before a final version is being accepted. The exam can therefore go through various stages of quality assurance during which it will be validated by various users or groups of users before a final version is drafted. Moreover, the quality assurance process surrounding the creation of exams has an impact on the items themselves, as these can be modified at any time by the users involved in the exam quality assurance process.

Roles

Six roles have been identified in the framework of item use:

- **Item selection officer**
Responsible for the selection of items for a particular exam, and for the creating and management of exam blueprints
- **Exam quality assurance officer**
Responsible for defining the exam quality assurance process and to quality assuring exams
- **Exam QA workflow manager officer**
Responsible for defining the exam quality assurance process and to quality assuring exams
- **Exam data gathering officer**
Responsible for gathering and inputting item performance metadata into the system

Functionalities

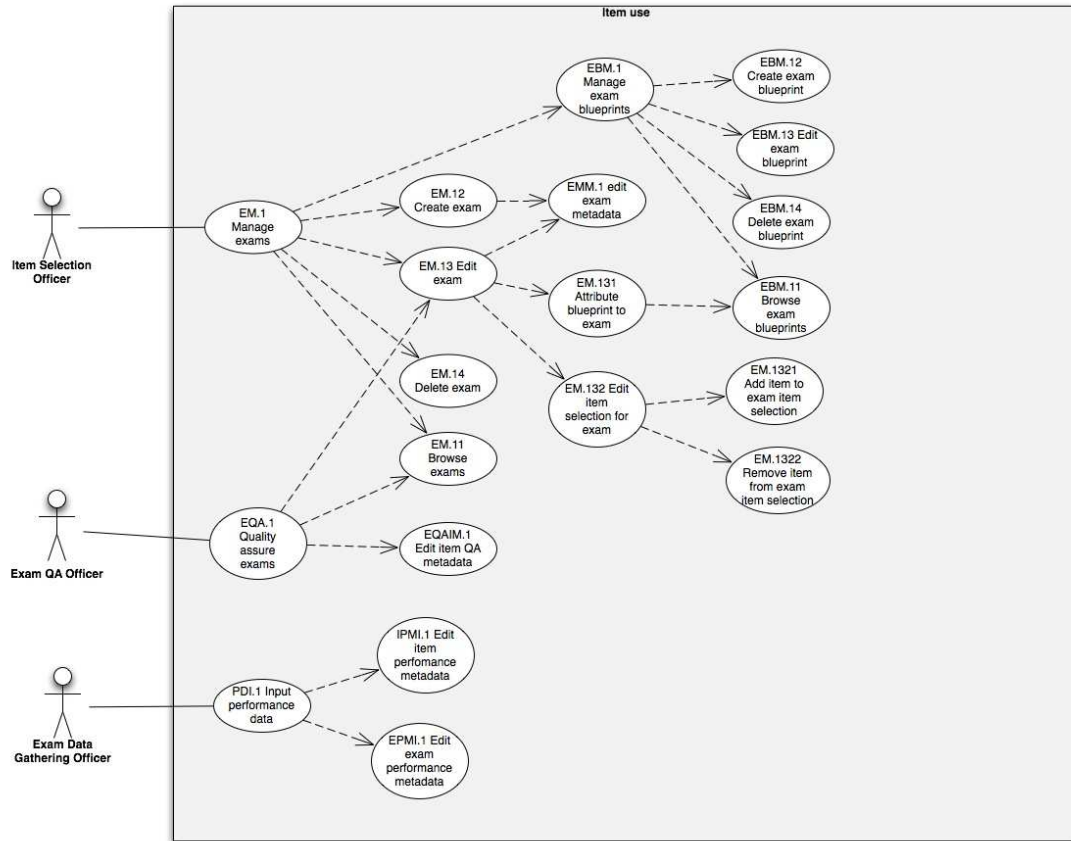


Fig.9 Use case diagram: Item use

Item selection officer

- ***EM.1 Manage exams***
 - EM.12 Create exam
 - EMM.1 Edit exam metadata
 - EM.13 Edit exam
 - EMM.1 Edit exam metadata
 - EM.131 Attribute blueprint to exam
 - EBM.11 Browse exam blueprints
 - EM.132 Edit item selection for exam
 - EM.1321 Add item to exam item selection
 - EM.1322 Remove item from exam item selection
 - EBM.1 Manage exam blueprints
 - EBM.12 Create exam blueprint
 - EBM.13 Edit exam blueprint
 - EBM.14 Delete exam blueprint
 - EBM.11 Browse exam blueprints

Exam quality assurance officer

- ***EQA.1 Quality assure exams***
 - EM.11 Browse exams
 - EM.13 Edit exam
 - EQAIM.1 Edit item QA metadata

Exam data gathering officer

- ***PDI.1 Input performance data***
 - IPMI.1 Edit item performance metadata
 - EPMI.1 Edit exam performance metadata

References

Benyon, D., Turner, P. and Turner, S. (2005) *Designing Interactive Systems: People Activities, Contexts, Technologies*. pp 253-265 Essex: Pearson Education Limited.

Charmaz, K. (2003). *Grounded theory: objectivist and constructivist methods*. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (2nd ed.). Thousand Oaks, CA: Sage.