



Visualization of Academic Quality Assurance Metamodel Through the Creation of Academic Quality Assurance Metamodel Information System

Rashidah Mokhtar¹, Siti Hajar Othman², Nur Huda Jaafar¹, Mardziyana Mohamad Malom^{3*}, Rohaizan Ramlan⁴

¹Faculty of Computer and Mathematical Sciences,
Universiti Teknologi MARA Segamat Campus, Segamat, 85000 Johor, MALAYSIA

²Faculty of Engineering, School of Computing,
Universiti Teknologi Malaysia, Johor Bahru, 81310, Johor, MALAYSIA

³Faculty of Business and Management,
Universiti Teknologi MARA Segamat Campus, Segamat, 85000 Johor, MALAYSIA

⁴Faculty of Technology Management and Business,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400 Johor, MALAYSIA

*Corresponding Author

DOI: <https://doi.org/10.30880/jscdm.2022.03.02.007>

Received 04 October 2022; Accepted 29 October 2022; Available online 01 November 2022

Abstract: Academic quality assurance metamodel information system (AQAMIS) is a mobile-web-friendly system designed to manage academic quality assurance (AQA) knowledge structure for higher education using the AQA metamodel structure. This research describes the development and functionality of AQAMIS, as well as how it visualizes the AQA metamodel on a system-based level. The AQAMIS system transformed the metamodel class diagram design into a user-friendly design, making it easier for any non-technical user to understand the metamodel design. The AQAMIS is composed of two major parts: the AQA metamodel and the knowledge repository system. The metamodel addresses the issue of managing knowledge for quality assurance in higher education. While the system resolves the issue of sharing best practices in higher education AQA. The AQAMIS system assists in ensuring that academic quality assurance systems are implemented more efficiently and effectively in higher learning institutions (HLIs). AQAMIS is also a one-stop center for respective users such as HLI top management, policymakers, auditors, and quality assurance personnel to access their expertise and share best practices in AQA endeavors.

Keywords: Academic quality assurance, metamodel, information system, program accreditation

1. Introduction

When discussing quality assurance in higher education, it refers to the preparation of documents in order to obtain accreditation and recognition from professional bodies, such as collecting, aggregating, analysing, and gathering data to produce appropriate required documents (Aljarallah & Dutta, 2022). The programme accreditation is defined as an approach to determine the level of programme quality requirements which is set up by qualification agency, for example Malaysian Qualifications Agency (MQA)(Malaysia Qualification Agency, 2018). While academic quality assurance (AQA) term is defined as a systematic management approach and assessment procedures to monitor the performance of HLIs in order to achieve the quality objectives, quality output and for improvements (United Nations Educational Scientific and Cultural Organization, 2000). The main aim of the AQA system is to gain the stakeholders confidence through delivering proper evidence of the quality in order to achieve the outcomes. In Malaysia, to fulfil the quality assurance system requirements, HLIs need to prepare the accreditation documents manually in order to get the self-accreditation recognition based on the guideline given. Furthermore, accreditation is crucial because it establishes a set of quality criteria for all educational institutions, gives access to federal and national funds, preserves trust in the private sector, and enables credit transfer (Aljarallah & Dutta, 2022).

In current practise, the quality assurance system recommends each higher learning institution (HLI) to obtain programme accreditation in order to gain recognition and trust from stakeholders. HLIs must prepare documentation based on the authority's guidance in order to obtain accreditation. However, preparing the AQA documentation is time-consuming, complex, and expensive, and there is currently no openly shared best practise resource (Mokhtar et al., 2016). According to recent research by Aljarallah & Dutta (2022), officers spend a significant amount of time preparing documents for the accreditation programme and may eventually lose interest in the process. Furthermore, there is a lack of an automated system for preparing documents for accreditation, and one is desperately needed. Since there is lack of sharing of good practices during the documentation's preparation, this may lead to misunderstanding. As a result, there is a need to manage and organise quality assurance knowledge in a systematic manner, followed by the development of a related information system to complement the current application of the AQA system. A generic and common domain knowledge concept must be developed among implementers to facilitate the sharing of best practises and better decision-making while preparing the AQA documentation.

In this study, an academic quality assurance metamodel information system (AQAMIS) is proposed to manage the concepts in AQA. AQAMIS organises AQA concepts into five categories: curriculum design, curriculum delivery, assessment, programme monitoring and review, and continuous quality improvement. These categories are related to programme management in higher education. All AQA concepts are derived from the AQA metamodel that has been developed before this. A metamodel is a communication medium between users that includes the abstract syntax, concrete syntax, and semantic syntax of a domain language (Mani et al., 2018). A metamodel's abstract can be defined by identifying the relevant concepts and their relationships (Bezivin & Gerbe, 2001). In this paper we will not discuss on the development of AQA metamodel. The development of AQA metamodel was explained in a book section by Mokhtar et al. (2021). We only show the outcome from the metamodel which store in AQAMIS. This system will be used to store the knowledge structure for the stakeholders' references. Therefore, the purpose of this study is to describe the development of AQAMIS and visualizing the AQA metamodel. The paper is organised as follows: 2. Architecture of AQAMIS, 3. User interface of AQAMIS, 4. Demonstration of AQAMIS, and 5. Conclusion.

1.1 Existing Information System Related to Accreditation Process

Prior research discusses on the best practices for implementing AQA business process by HLIs globally. Some of the good practices were implemented in information systems to store and share the work processes. Southeast Asian Ministers of Education (SEAMEO RIHED, 2012) also recommended the development of a systematic AQA system for the internal and national systems in order to improve system clarity and foster the sharing of best practices across borders and cultures. Several information systems geared toward the AQA system have been created, including a database system for program improvement (Booth, 2006) and an iDMQA system to manage documents related to the accreditation program (Mokhtar, Jaafar, et al., 2014). Furthermore, the ACAT system is designed for course evaluation (Essa et al., 2010), the IQIS system is designed for continuous improvement (He, Cui, and He, 2006), and the aCQI system is a technology-based system designed to support AQA management through the use of an agent-mediated element (Ismail and Ahmad, 2015). It demonstrates that various researchers have focused on the AQA domain in order to provide the best solutions to improve the AQA system. Refer to Table 1 for existing information systems and its contribution to quality assurance system in HLI.

The usage of information system will give a positive impact in order to encourage people to embrace the AQA culture, thus at once optimizing the quality in HLIs.

Table 1 - Prior research on the AQA information system

Researcher	Information system	Contribution	System limitation
Ismail & Ahmad (2015)	Agent-Mediated Continual Quality Improvement (CQI) system	Focus on curriculum development components of AQA	Not covered all AQA process
Mokhtar, Jaafar, Tahar, Sukiman, & Bakar (2014)	Integrated Document Management System (iDMQA).	Focus on managing the documents for accreditation application	Only manage the documents not the AQA workflow process
Booth (2006)	Database system for programme improvement	Propose a database that shows the improvement process for programme	This database almost similar to the propose system but limited to the flow of programme improvement not monitoring the process.
Essa <i>et al.</i> (2010)	ACAT system for course assessment	Design an assessment system for course.	Covered the assessment components only.
COMPASS	COMPASS is an automated generation of self-evaluating and evaluating reports, supporting documents and references.	Managing process and documents in the AQA for accreditation approval.	Not cover the workflow in AQA process.
Hadzhikoleva and Hadzhikolev (2016)			
Febriadi & Riharjo (2022)	Management Information System (SIM) Accreditation	This system will serve as a data centre, generate hardcopy and softcopy accreditation forms for study programmes and universities, and be able to simulate the possibility of obtaining study programme accreditation based on data and documents entered into information technology-based systems.	Covered all process of accreditation based on guideline given by authority.
Kommej et al. (2022)	AccSOFT is an accreditation web-based system	AccSOFT aims to provide an easy way to track the accreditation status of all programmes in a university or institution of higher education, as well as to automatically generate materials required for the NAB accreditation process.	Covered process of tracking accreditation status.

2. Architecture of AQAMIS

AQAMIS' architecture is depicted in Figure 1. It is divided into three sections: input, process, and output. The input is a new problem (Q1) derived from the domain's user. While the output is a new solution (Q2) that is delivered to the actual user. AQAMIS is made up of three modules: Module A is the AQA metamodel, Module B is the system's AQA knowledge repository, and Module C is the user interface and retrieval engine of the quality assurance management system. When the AQA metamodel is finished, the model fragment, notation, and rules are combined to build the repository structure. All AQA-related tables, such as quality assurance data, historical data, metamodel example, and data from agencies, are embedded in the repository. This system can be used by users such as higher education top management, policy makers, quality assurance unit, practitioners, and students to retrieve information relevant to their problem and assist them in decision making.

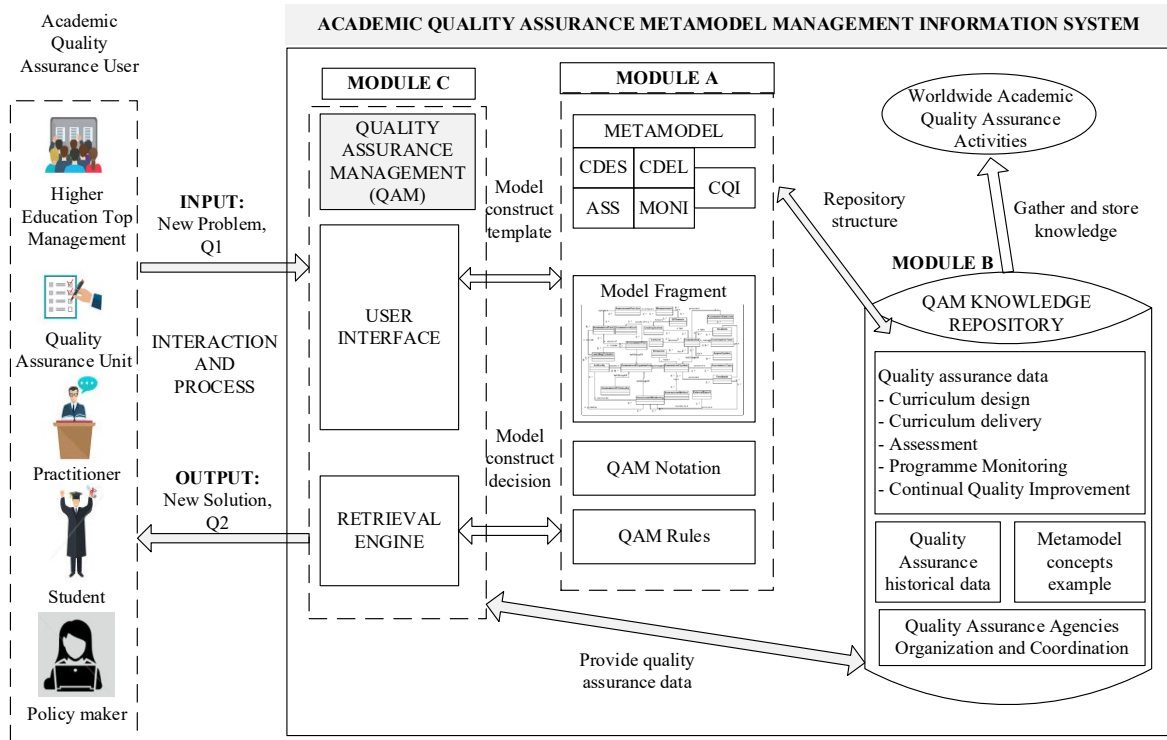


Fig. 1 - Architecture of AQAMIS

The development of AQAMIS is based on the structure of AQA metamodel. Every AQA metamodel concept is represented as Class, namely *AQAMClass*. A class consist of class name, class id, concept, attribute, operation and relationship. It is represented in the following notation.

AQAMClass::=<AQAMClassName, AQAMClassID, AQAMClassTerminology, AQAMClassAttribute, AQAMClassOperation, AQAMClassRelationship>

where:

- AQAMClassName* represents an AQA concept name
- AQAMClassTerminology* represents an AQA concept definition
- AQAMClassAttribute* represent an AQA requirement
- AQAMClassOperation* represent an AQA task
- AQAMClassRelationship* represents the relationship with other concept/s
- AQAMClassID* is a unique identifier for the concept

(Note: Symbol ::= is an equivalent).

2.1 System Structure of AQAMIS

The AQAMIS system was built with a MySQL database, PHP5 as the back end engine, and HTML5, JavaScript, and CSS3 Bootstrap as the front end graphical user interface. The foundation of a website is built using Hypertext Mark-up Language (HTML). Together with PHP5, HTML5 is used to create the AQAMIS. JavaScript is another scripting language that helps with web development. Based on the requirements, these languages are used to develop the system. All features such as adding information, deleting information, and searching for information were built. The metamodel structures were saved in a MySQL database via the Apache web server, and the end user can access them via an online website.

2.2 Database Design

AQAMIS used MySQL or structured query language as a database to store AQA practises. MySQL is the most popular open source relational database management system due to its performance, capability, dependability, and ease of use. The repository system makes use of 15 tables in total. As shown in Figure 2, each area of evaluation is represented by three tables: *umldesign* (to store concepts), *defdesign* (to store definitions), and *detaildesign* (to store best practises).

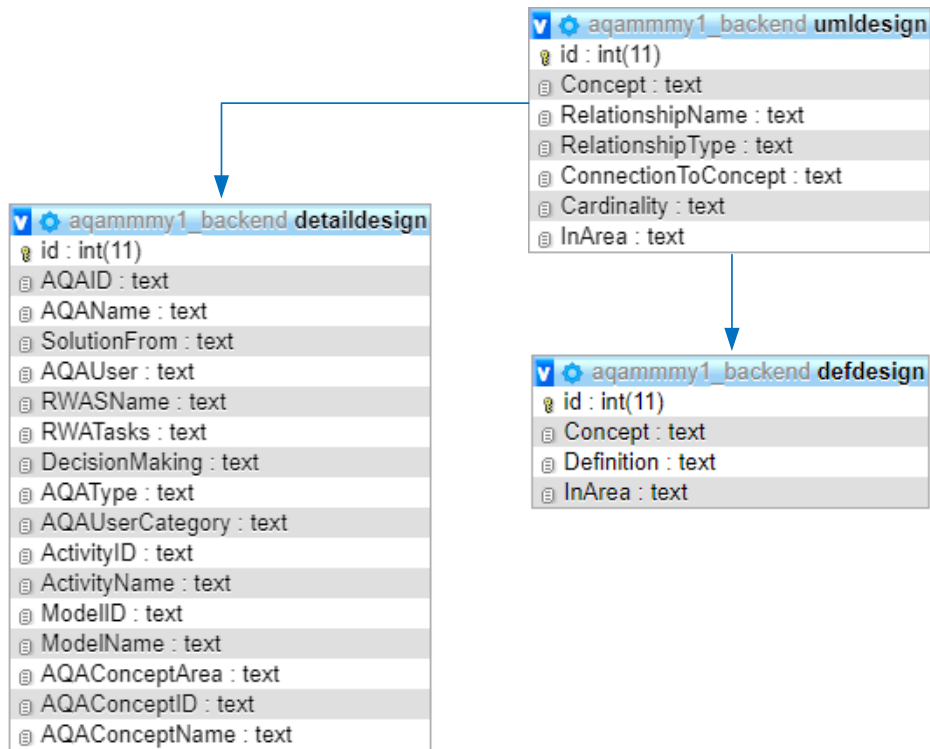


Fig. 2 - Sample of tables for curriculum design-AQA metamodel database

Figure 3 demonstrates the sample of data from *umlDesign* table which stores the details of the concepts underpin concept, relationship name, relationship type cardinality and area of evaluation and sample data from *defdesign* table that stores the definition for the curriculum design concepts.

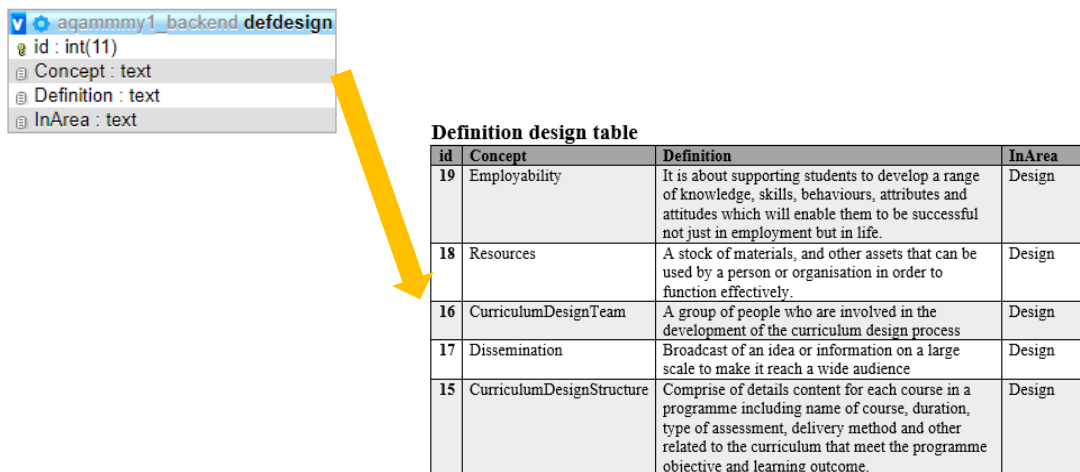


Fig. 3 - Samples of data values for the *concept_table* and *definition_table* for Curriculum design

2.3 Information architecture design

Information architecture of AQAMIS illustrated into five components that correspond to the area of evaluation in the AQA metamodel structure: design (curriculum design), delivery (curriculum delivery), assessment (student assessment), monitoring and review (programme monitoring and review), and improvement (continual quality improvement). Each component contains a UML diagram, a concept list, a concept definition, and a concept solution (as shown in Figure 4). UML diagrams connect concepts with the appropriate relationships shown in class diagrams. Concept lists structure all concepts added to the database, along with concept definitions. The final module is the concept solution, which is a collection of the best practises in the AQA process that have been organised according to the proposed metamodel.

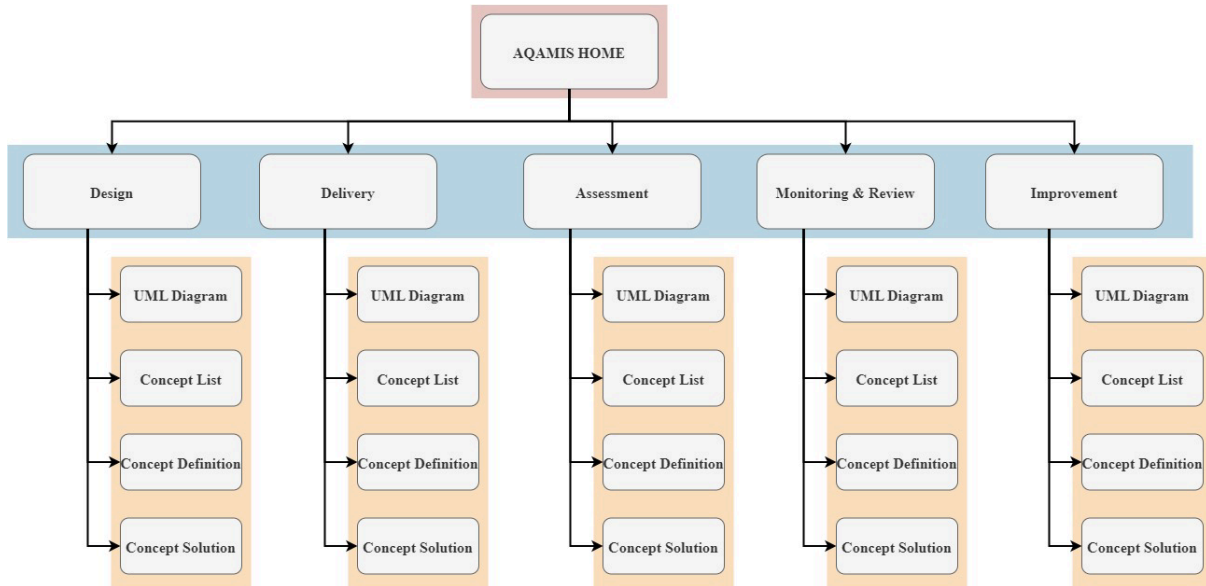


Fig. 4 - Organisation map for the AQAM-KR system

3. User Interface of AQAMIS

User interfaces of AQAMIS were designed with user friendly elements. The menu is on the left side of the web design. Together there are five main menus which related to the main areas of AQA in higher education as designed in the information architecture. The menu are **Design** (for curriculum design), **Delivery** (for curriculum delivery), **Assessment** (for assessment), **Monitoring and review** (for programme monitoring and review) and **Improvement** (for continual quality improvement). There are two levels of user, each with their own interfaces and functions. The following section will show the user and admin views.

3.1 User view

User is a kind of general user who is involved in quality assurance in higher learning institutions. Example of users are quality unit, auditor, academician, policy maker and quality assurance agency. Figure 5 illustrates a home menu interface for user view. The home menu displays the relationships between five areas of evaluation in the centre.

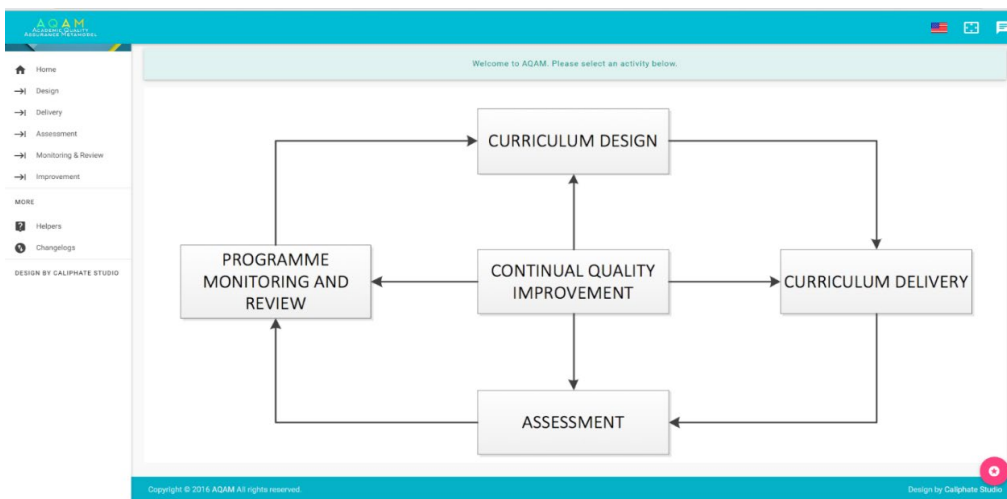


Fig. 5 - Home menu interface of AQAMIS

When a user click one of the menu, for example user choose curriculum design, an UML class diagram will appear as in Figure 6. There are an UML class of diagrams show the concepts and relationships connected each other. User can also click menu at the left side of the system to display the UML diagram according to the area of domain. Each of the area such as Delivery, Assessment, Monitoring and Review and Improvement also has the same interface view as Design area.

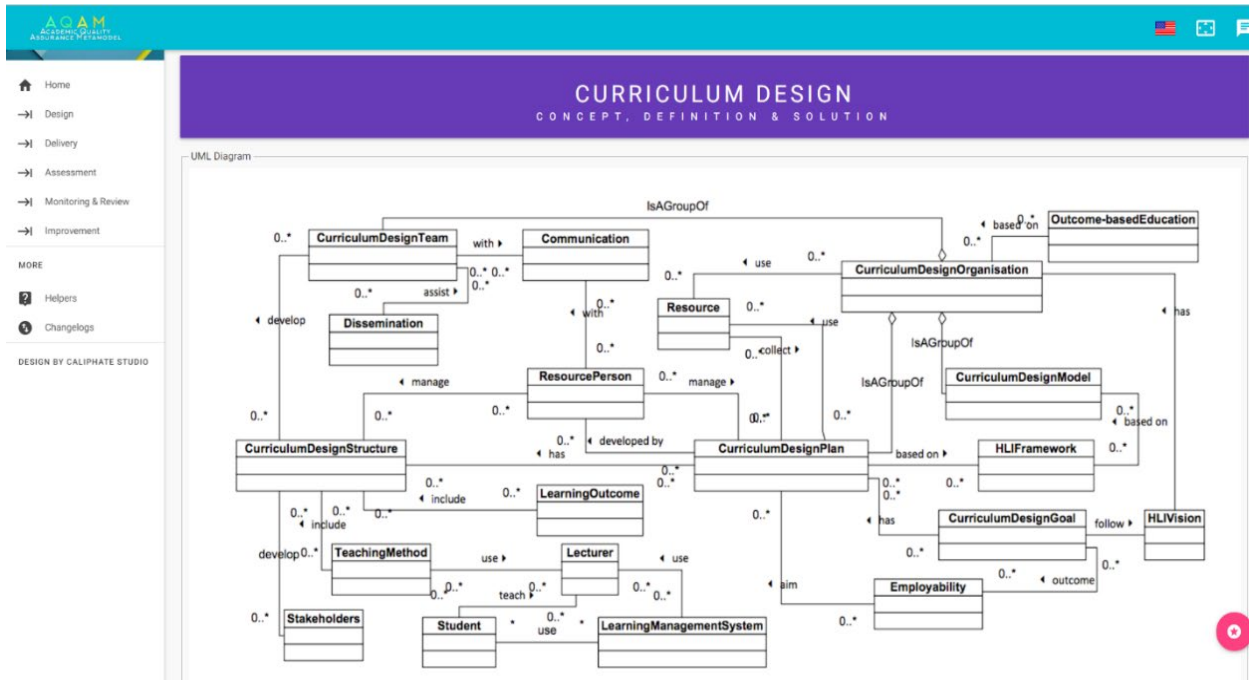


Fig. 6 - Design menu interface of AQAMIS

Beside UML class diagram, the list of concepts with the relationship details is shown in the table as in Figure 7. The user can also look at different concepts of area by choosing the menu at the left side of the interface.

Concept Name	Relationship Name	Relationship Type	Connection	Cardinality	In Area
Communication	IsAGroupOf	Association			Design
Curriculum design goal	IsAGroupOf	Association			Design
Curriculum design model	IsAGroupOf	Association			Design
Curriculum design plan	IsAGroupOf	Association			Design
Curriculum design structure	IsAGroupOf	Association			Design
Curriculum design team	IsAGroupOf	Association			Design
CurriculumDesignOrganisation	IsAGroupOf	Association	CurriculumDesignPlan	0..*	Design
Dissemination	IsAGroupOf	Association			Design
Employability	IsAGroupOf	Association			Design
HLI framework	IsAGroupOf	Association			Design

Fig. 7 - Concept list view in design area of AQAMIS

Another function embedded in the system is the definition for each of the concepts. The definitions are listed in a table as presented in Figure 8. To see definition for other area, user can click the menu at the left side of the interface.

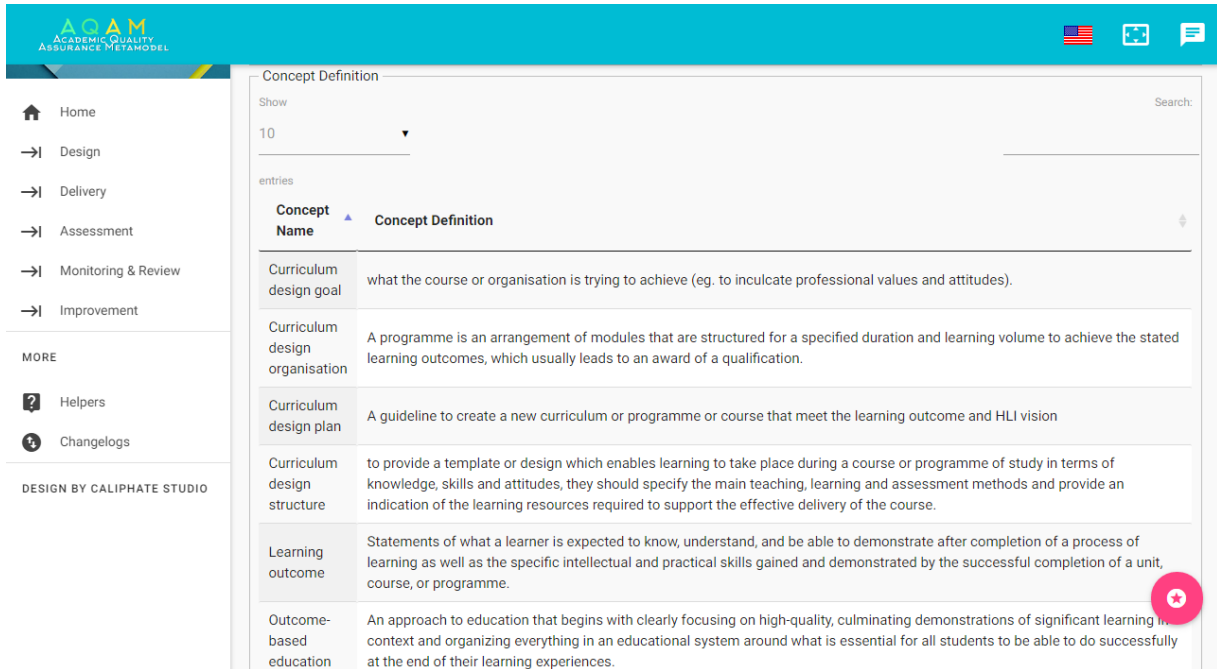


Fig. 8 - Concept definition view in design area of AQAMIS

The most important contribution of the system is sharing best practices in the academic quality assurance domain. The best practices are shared in the Concept solution module. Figure 9 demonstrates the example of solution view for Assessment Area. While Figure 10 presents a sample of solution view for Appeal System concept in the Assessment Area. The user can read and learn the practices easily through the system. The concept solution is viewed according to the concept and type of user. To see details of the solution, the user needs to click the list in Figure 9.

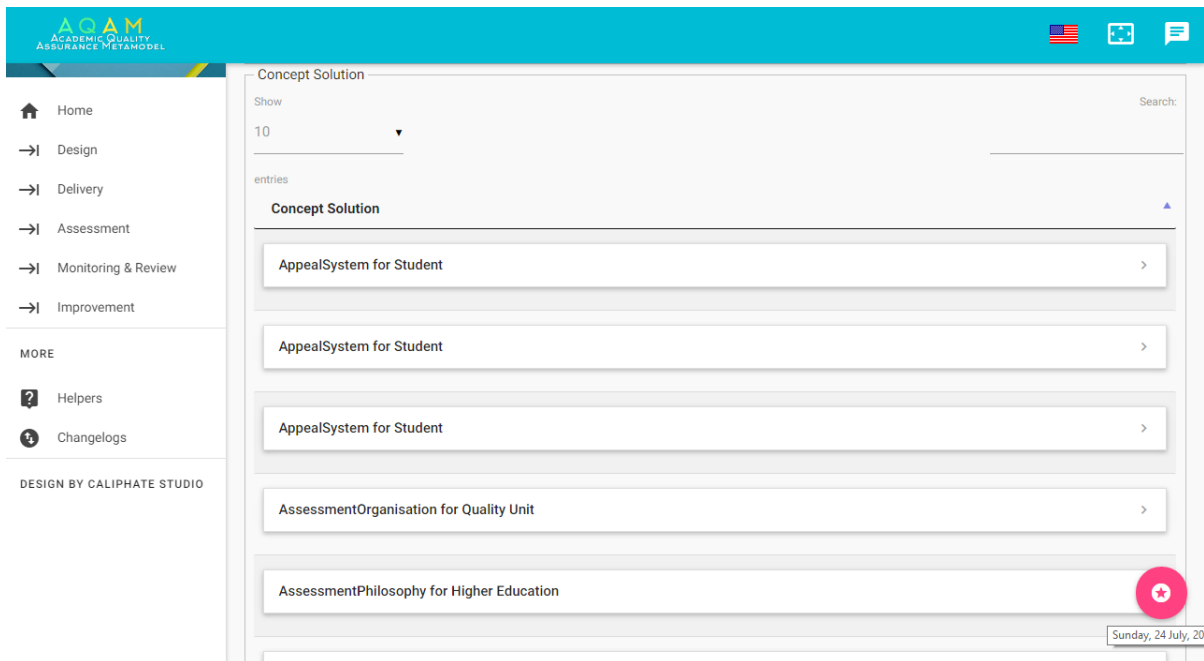


Fig. 9 - Concept solution view in assessment area of AQAMIS

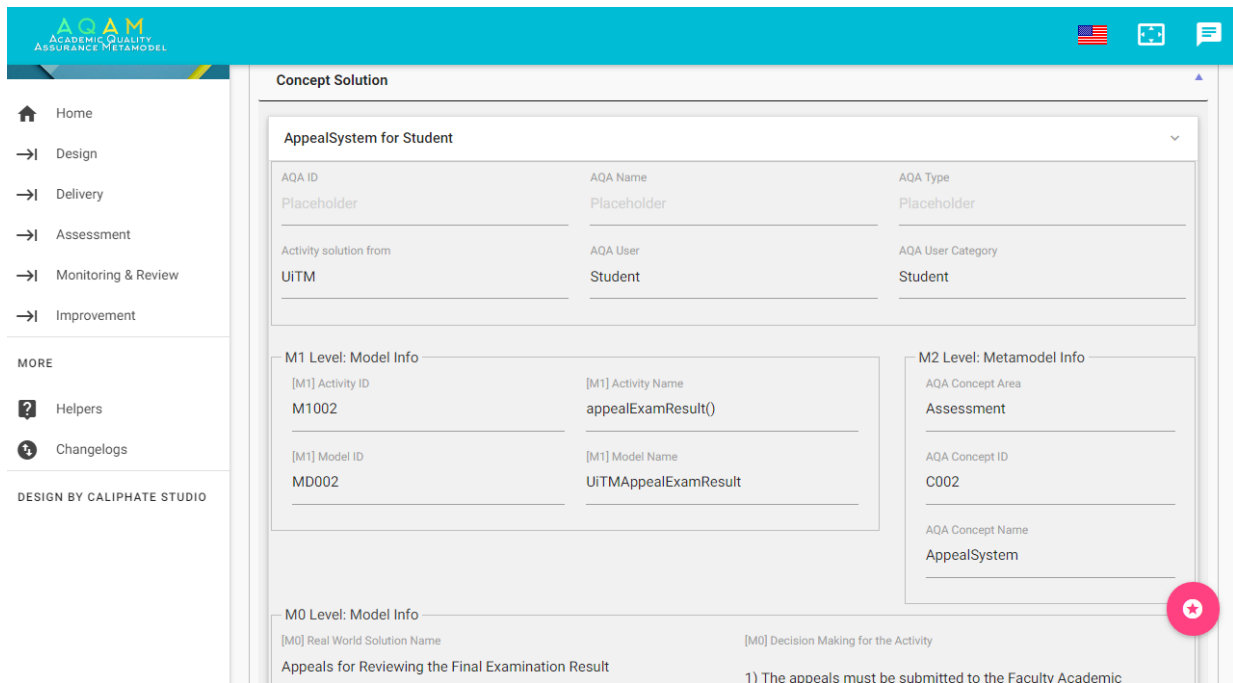


Fig. 10 - Sample of concept solution in appeal system (assessment area)

3.2 Admin view

This section will look into the interface for Admin user who is in charge of the system. The admin has the ability to edit existing concepts, add new concepts, and delete concepts. When an administrator enters the URL address for the admin site, the Home menu interface appears (see Figure 11). The dashboard concept is used for the admin interface. It displays database statistics such as total concepts, total definitions, and total solutions.

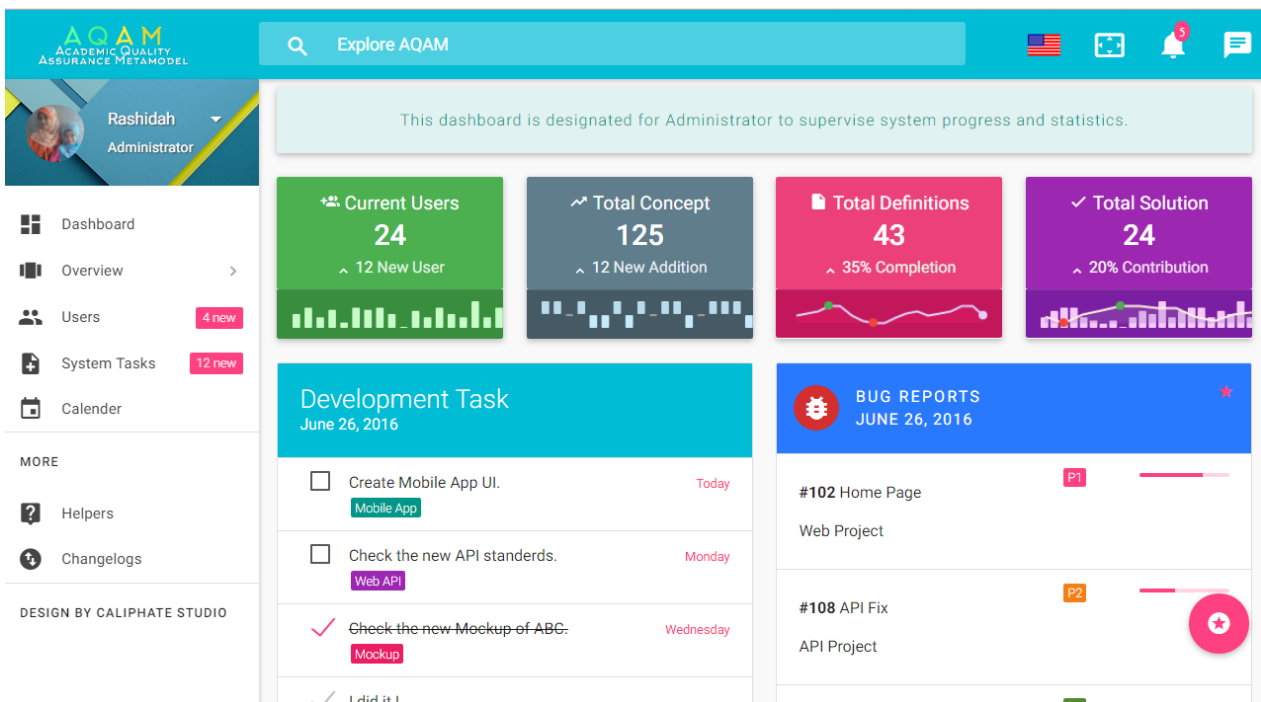


Fig. 11 - Home menu for admin view of AQAMIS

4. Demonstration of AQAMIS

In this section demonstrates the application of metamodel in the AQAMIS system. As mentioned, the system is a metamodel-based system where the structure of the system is constructed based on the metamodel design. Figure 12 demonstrates the application of AQA metamodel together with repository system. Domain users such as policy maker, quality unit and HLIs (Step 1) requested the metamodel structure through the AQAMIS system when they search the concepts related to the AQA knowledge (Step 2). The keyword search will be matched with the AQA concepts, attributes and operations related (Step 3) to view the details of the concepts. Then, it will view the details of concepts through fragmentation of models (Step 4) which store in the repository system database. The data of specific model is retrieved from the collection of case studies which the structure is stored in the database (Step 5). The domain user get the requested results produced from the model fragmentation (consist of concepts properties) and then it is display in the friendly user interface (Step 6).

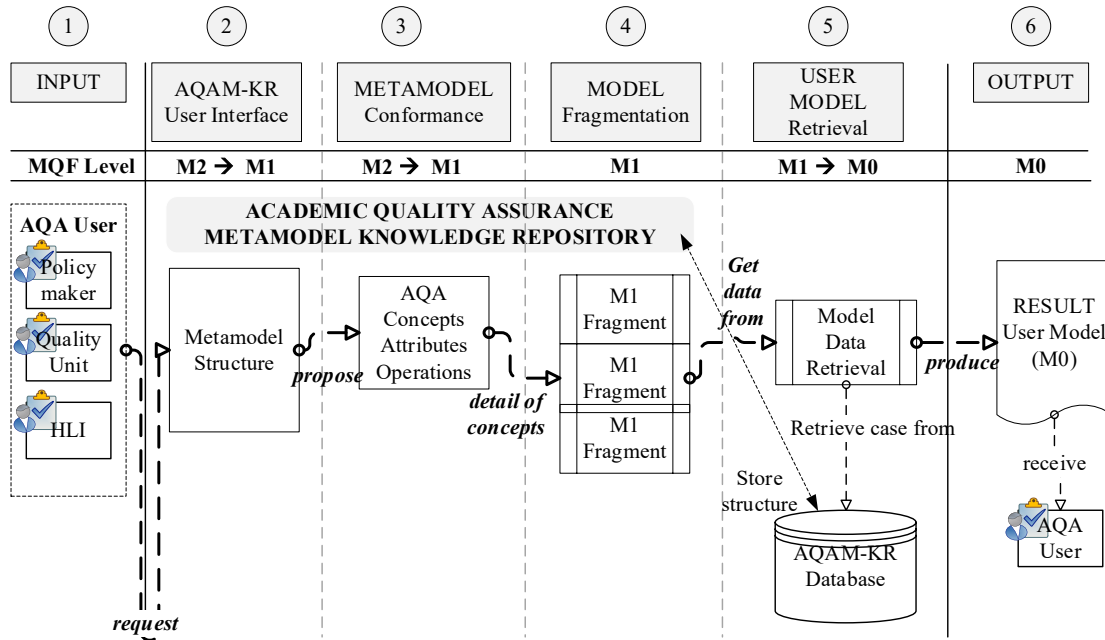


Fig. 12 - The AQAMIS demonstration of metamodel application

Managing the quality assurance process is decisive for improving the quality, increasing the net benefit, reducing the flaws, for sustainability and optimizing the quality in various domains and most importantly in the academic area. The use of information systems will have a positive impact in encouraging people to embrace the AQA culture, thereby optimising HLI quality. The following are some of the advantages of the AQAMIS system:

- Helps the stakeholder to understand the AQA process through the metamodel structure.
- It offers an alternative guideline to the stakeholders other than the documented reports.
- The system will assist users in decision making and it will reduce the time of searching the related solutions.
- It will speed up the learning process of AQA processes among newcomers as all concepts related is available in the system.
- The development of a new system or adoption of a system to a new platform is cheaper and it reduces the cost of time since the requirements already identified.

5. Conclusion

The AQAMIS system represents the whole picture of AQA activities in a form of metamodel which comprises of concepts, relationships and rules related to managing programmes and courses in higher education. The system ables to store existing best practices of AQA from HLIs all over the world using the proposed metamodel. The AQAMIS has several maintenance functions such as add, edit and delete to make the repository content dynamic (such as concepts, definition of concepts and share the best practices). It is a one stop centre for knowledge management repository for respective stakeholders such as HLIs top management, policy makers, auditors, administrators, academic staff and quality people in academic quality assurance. The experienced AQA practitioners can share their tacit knowledge through AQAMIS system and ultimately improve the overall quality of HLIs education. We believe that the AQAMIS

system could help HLI implement academic quality assurance systems more efficiently and effectively. By sharing best practises in the AQAMIS, all stakeholders will be able to fully utilise and benefit from the system.

Acknowledgement

This work is supported and funded by the Universiti Teknologi MARA Cawangan Johor, Segamat Campus.

References

- Aljarallah, N. A., & Dutta, A. K. (2022). Developing a Quality Automation Framework to Assess Specifications for Academic Accreditation in Saudi Arabian Universities. *TEM Journal*, 11(2), 667–674. <https://doi.org/10.18421/TEM112-21>
- Bezivin, J., & Gerbe, O. (2001). Towards a precise definition of the OMG/MDA framework. *Proceedings 16th Annual International Conference on Automated Software Engineering (ASE 2001)*, 273–280. <https://doi.org/10.1109/ASE.2001.989813>
- Booth, L. (2006). A database to promote continuous program improvement. *Proceedings of the 7th Conference on Information Technology Education - SIGITE '06*, 83. <https://doi.org/10.1145/1168812.1168834>
- Essa, E., Dittrich, A., Dascalu, S., & Jr., F. C. H. (2010). ACAT: A Web-Based Software Tool to Facilitate Course Assessment for ABET Accreditation. *2010 Seventh International Conference on Information Technology: New Generations*, 88–93. <https://doi.org/10.1109/ITNG.2010.224>
- Febriadi, B., & Riharjo, I. B. (2022). ANALYSIS OF THE EFFECT OF QUALITY ASSURANCE AND INFORMATION TECHNOLOGY ON HIGHER EDUCATION ACCREDITATION PERFORMANCE (Case *International Conference of Business and Social ...*, 185–194. <http://61.8.77.171/index.php/icobuss1st/article/view/167%0Ahttp://61.8.77.171/index.php/icobuss1st/article/download/167/151>
- Hadzhikoleva, S., & Hadzhikolev, E. (2016). The COMPASS-OK Model for Quality Assurance in Higher Education. *International Journal of Applied Engineering Research*, 11(11), 7326–7332. http://www.ripublication.com/ijaer16/ijaerv11n11_23.pdf
- Ismail, S., & Ahmad, M. S. (2015). A Goal-based Framework on Contextual Requirements Modelling for Agent-mediated Continual Quality Improvement (aCQI) in Curriculum Design. *Proceedings of the 9th International Conference on Ubiquitous Information Management and Communication*, 8.
- Kommey, B., Gyimah, F., Kponyo, J. J., & Andam-Akorful, S. A. (2022). A Web Based System for Easy and Secured Managing Process of University Accreditation Information. *Indonesian Journal of Computing, Engineering and Design (IJoCED)*, 4(1), 17. <https://doi.org/10.35806/ijoced.v4i1.240>
- Malaysia Qualification Agency. (2018). *Code od Practice for Programme Accreditation (Second)*. Malaysian Qualification Agency.
- Mani, N., Helfert, M., Pahl, C., Nimmagadda, S. L., & Vasant, P. (2018). Domain Model Definition for Domain-Specific Rule Generation Using Variability Model. In *Innovative Computing, Optimization and ITs Applications, Studies in Computational Intelligence* (Issue January, pp. 39–55). Springer International Publishing. <https://doi.org/10.1007/978-3-319-70542-2>
- Mokhtar, R., Jaafar, N. H., Tahar, N. F., Sukiman, S. A., & Bakar, N. F. A. (2014). An Integrated Document Management System for Managing Self Programme Accreditation Using Scrum Approach. *2014 International Symposium on Technology Management and Emerging Technologies (ISTMET 2014)*, 102–106.
- Mokhtar, R., Othman, S. H., & Ramlan, R. (2021). SERVICE AND OPERATIONS MANAGEMENT Series 3. In R. Ramlan (Ed.), *Penerbit UTHM* (First, pp. 98–112). Penerbit UTHM. https://doi.org/10.1007/978-3-030-15293-2_3
- Mokhtar, R., Rahman, A. A., & Othman, S. H. (2016). The Design of the Academic Quality Assurance Management Information System. *2016 International Conference on Information in Business and Technology Management (I2BM)*, 1–6.
- SEAMEO RIHED. (2012). *A Study on Quality Assurance Models in Southeast Asian Countries : Towards a Southeast Asian Quality Assurance Framework*.
- United Nations Educational Scientific and Cultural Organization. (2000). Quality Assurance in Higher Education: Standards, Mechanism and Mutual Recognition. In G. Harman (Ed.), *International Conference on Quality Assurance in Higher Education: Standards, Mechanism and Mutual recognition* (p. 255).