UML-Based Life Cycle for the King Saud University Scientific Excellence Prize System

Abdulhameed Alelaiwi

College of Computer and Information Sciences, King Saud University, Riyadh 11543, Saudi Arabia
{alelaiwi }@ksu.edu.sa

Abstract: Web-based applications face many challenges, such as internal and external integration, automatically controlling and adapting internal processes based on the organizational view, and improving the Quality of Service (QoS). The aim of this study was to deploy a unified web-based platform that addresses these challenges and drives the internal execution processes of a real-life system. The King Saud University Award for Scientific Excellence (KSU-ASE) is composed of seven branches, each with its own prize to be awarded in different areas of scientific achievement. Using the KSU-ASE prize system as a case study, we proposed and developed a new framework for dynamically deploying a web-based application, based on UML analysis and design models. The framework is primarily composed of two levels: the operational and the controller level. At the operational level, we developed and implemented web-based subsystems for the different branches of the KSU-ASE prize system. The controller level is composed of three sub-components. The first component is workflow viewers, which are responsible for extracting and viewing the internal workflow processes for each of the KSU-ASE subsystems and for representing their behaviors using sequence diagrams. The structure of each system is illustrated using model–view–controller design style. The second component is the subsystem-evaluator, which verifies the execution of each subsystem using a specific test case based on a well-defined test plan. The third component is the subsystem-optimizer, which is responsible for applying the QoS criteria, such as response time, availability, and throughput. The base subsystems are internally integrated with other KSU systems, such as the KSU Enterprise Resource Planning (ERP) system and the scientific production database.
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1. Introduction

The King Saud University Scientific Excellence Prize was established by KSU to honor distinguished faculty members, researchers, and students within a spirit of scientific competition, and to further promote the standards of scientific research. The prize is annual, and aims to cultivate a distinguished, outstanding, and innovative scientific research environment. The motivations for initiating such a prize are as follows:

1. To serve the first objective of the KSU2030 Strategic Plan, promoting research quality and excellence by raising the academic and scientific standards of research to serve the community and contribute to the materialization of excellence in various scientific fields. To highlight its importance, this objective is listed as the top priority in the KSU2030 Strategic Plan.
2. To serve the various initiatives involved in strategic plan programming, especially those related to faculty members, emphasizing increased compensation and improved support. One of the objectives of this initiative is to provide faculty members with a supportive and stimulating environment that is conducive to increasing faculty members' performance and research output.
3. To embody the values adopted in founding the university, such as "quality and excellence" and "creativity and innovation."
4. To serve the Strategic Plan of the Deanship of Scientific Research, which comprises eight objectives, including:
   a. Research excellence in view of materializing international leadership;
   b. Development and consolidation of human resources at the university to promote scientific research outputs;
   c. Contribution to building a knowledge-based society and supporting the priorities of industry and growth in the Kingdom; and
   d. Providing researchers and the research process with a stimulating research environment.

The prize comprises seven branches: (i) Lifetime Scientific Achievement Prize, (ii) Research Quality Prize, (iii) Research Productivity Prize, (iv) Inventions, Innovations, and Technology Licensing Prize, (v) Societal Partnership Research Prize, (vi)

Best-Authored Book Prize, and (vii) Student Research Excellence Prize.

The KSU-ASE Board and Executive Committee supervise the procedures of nomination and submission, according to the criteria and controls set up for each of the branches of the prize. The Executive Committee forms specialized jury sub-committees to choose the best candidates.

This paper describes the development and deployment of a unified web-based framework based on UML analysis and design models. In Section 2, we describe the proposed framework, the algorithm that describes the role of the proposed framework, and its structural components. In Section 3, we discuss the simulated case study and illustrate the experimental results. Related literature is discussed in Section 4. Finally, Section 5 presents the conclusions of this study, and possibilities for future work in this area.

2. Framework

In this section, we present the main framework, shown in Figure 2.1, and discuss its main components: the KSU-ASE branches as subsystems, its Board Committee, nomination processes, and evaluation criteria.

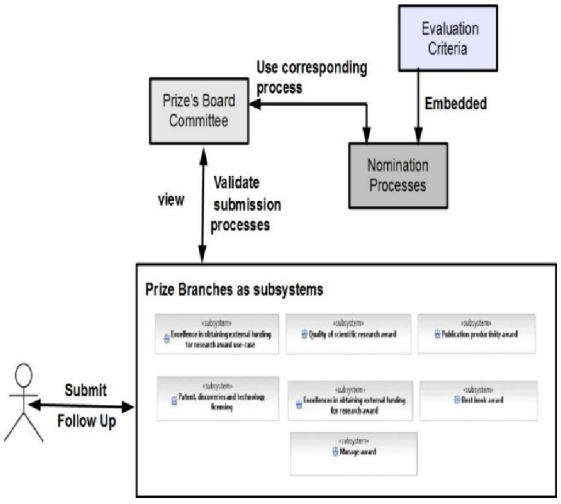

Figure 2.1. Proposed Framework Structure

As subsystems, the branches of KSU-ASE represent the core components of the framework; each subsystem has its own functionalities and particular processes. As outlined above, these branches are:

i. Lifetime Scientific Achievement Prize: This prize is awarded to a researcher whose scientific journey is distinguished by quality in research and academia throughout his/her academic career.
ii. Research Quality Prize: This prize is awarded to researchers whose work is characterized by the highest level of quality and excellence. This branch includes three prizes, corresponding to each of the following specializations: science and engineering, health sciences, and social sciences and humanities.
iii. Research Productivity Prize: This prize is awarded to the researchers with the most prolific scientific production in international outlets, in each of the science and engineering, health sciences, and social sciences and humanities specializations.
iv. Inventions, Innovations, and Technology Licensing Prize: This prize is awarded to three researchers whose work is mentioned in relation to scientific and health inventions and innovations, patents, and licensed technology, on the condition that such work has value-added scientific worth.
v. Societal Partnership Research Prize: This prize is awarded to three distinguished research projects resulting from societal partnership research between the university and the community, within the public, private, or charity sectors.
vi. Best-Authored Book Prize: This prize is awarded to the best-authored books in the science and engineering, health, and social sciences and humanities specializations.
vii. Student Research Excellence Prize: This prize is awarded to university undergraduate, postgraduate, and KSU students on scholarship abroad whose research is distinguished.

The second component of the framework is the KSU-ASE Board Committee. The Board adopts the general framework, the principles, and general objectives of the prize, as well as the organizational bylaws, their amendments, and the final declaration of the winners in each of the branches.

The third component is the nomination processes, which are responsible for assigning tasks to the Executive Committee. For example, such tasks may be:

- To formulate the bylaws that organize the prize, and propose amendments and updates to these bylaws;
- To supervise the procedures of announcing and receiving proposals;

- To select the scientific jury sub-committees;
- To choose the supporting administrative committees;
- To forward the list of nominees to the Board members;
- To perform other tasks requested by the Board.

The final component of the framework is the evaluation criteria for the awards, which are particular to each of the individual branches outlined above, as follows:

i. Lifetime Scientific Achievement Prize: prolific production, research leadership, research excellence, research impact, and research supervision;
ii. Research Quality Prize: research impact, research quality, research leadership, and research excellence;
iii. Research Productivity Prize: research quality, average contribution to the submitted research production, research leadership, and research impact;
iv. Inventions, Innovations, and Technology Licensing Prize: number of submitted articles that satisfy entry conditions, average of contribution compared to other applicants, and the societal, environmental, or economic yield expected of the invention or innovation;
v. Societal Partnership Research Prize: content and importance of the research partnership, size of the funds used in the research project, documented knowledge outcomes of the research partnership, number of KSU faculty members who took part in the research partnership, extent of reusability of the research partnership in undertaking other partnership projects, number of KSU students participating in the research partnership, and number of beneficiaries taking part in the research partnership;
vi. Best-Authored Book Prize: importance of the topic of the book, addition to human knowledge and originality, likelihood of the book to serve the community, methodology and comprehensiveness of book contents, and language proficiency, stylistic accuracy, and layout;
vii. Student Research Excellence Prize: number of articles published in ISI-indexed journals, journal rank according to scientific field, rate of student contribution to the submitted research articles, and overall citations of submitted research articles.

The proposed framework was implemented as a web-based platform for the KSU-ASE prize system. Its internal structure and behavioral components were analyzed and designed based on UML models, throughout the framework implementation life cycle.

3. Case Study

To simulate the proposed framework and check its go-live functionalities, we used the KSU-ASE prize system branches environment as a real-life case study. The analysis and design life cycle is based on UML models. In Figure 2, 3, and 4, the common use cases for some branches are illustrated and discussed.

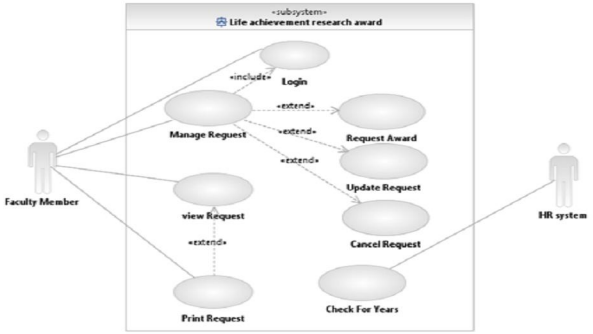

Figure 2. Use case model of the lifetime achievement research subsystem.

Figure 2 illustrates the main use cases of this subsystem, which are composite use cases named "manage request" and "print report," and a simple one named "check for years." Moreover, these use cases have direct interaction with two actors: faculty members and the human resources system.

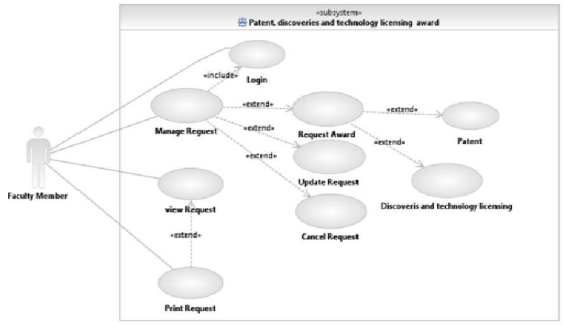

Figure 3. Use case model of the patent, discoveries, and technology-licensing award.

Figure 3 comprises two composite cases and its driven use cases.

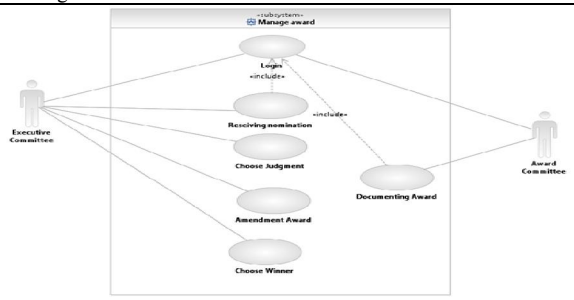

Figure 4. Use case model of award management.

Figure 4 shows the necessary use case to manage the prize through two main actors: the Award Committee and the Executive Committee.

The structure of our system is represented using UML classes. In Figure 5, the design classes of the lifetime achievement, quality of scientific research, and publication productivity awards are identified and classified based on the system's rules. Moreover, the relationships between the classes of this subsystem are established.

The behaviors that are associated with the interactions between the subsystems are illustrated in detail in two sequence diagrams below. As shown in Figure 6, the first sequence diagram illustrates the functionalities of the first subsystem.

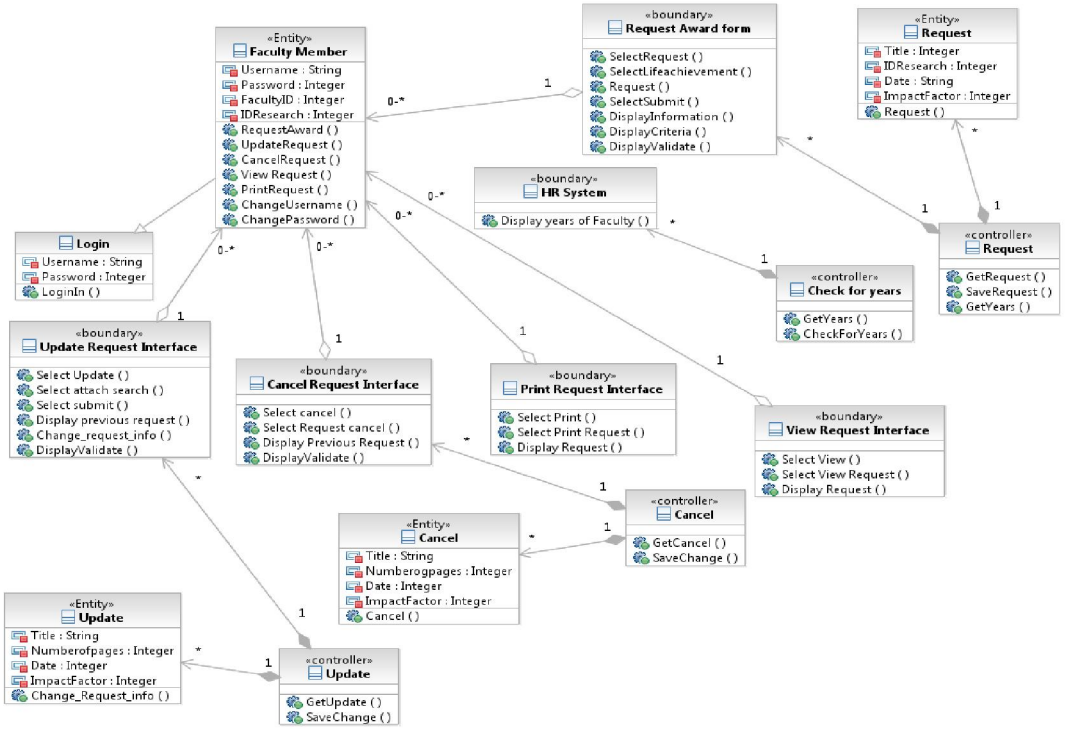

Figure 5. Design classes of the lifetime achievement, quality of scientific research, and publication productivity prizes.

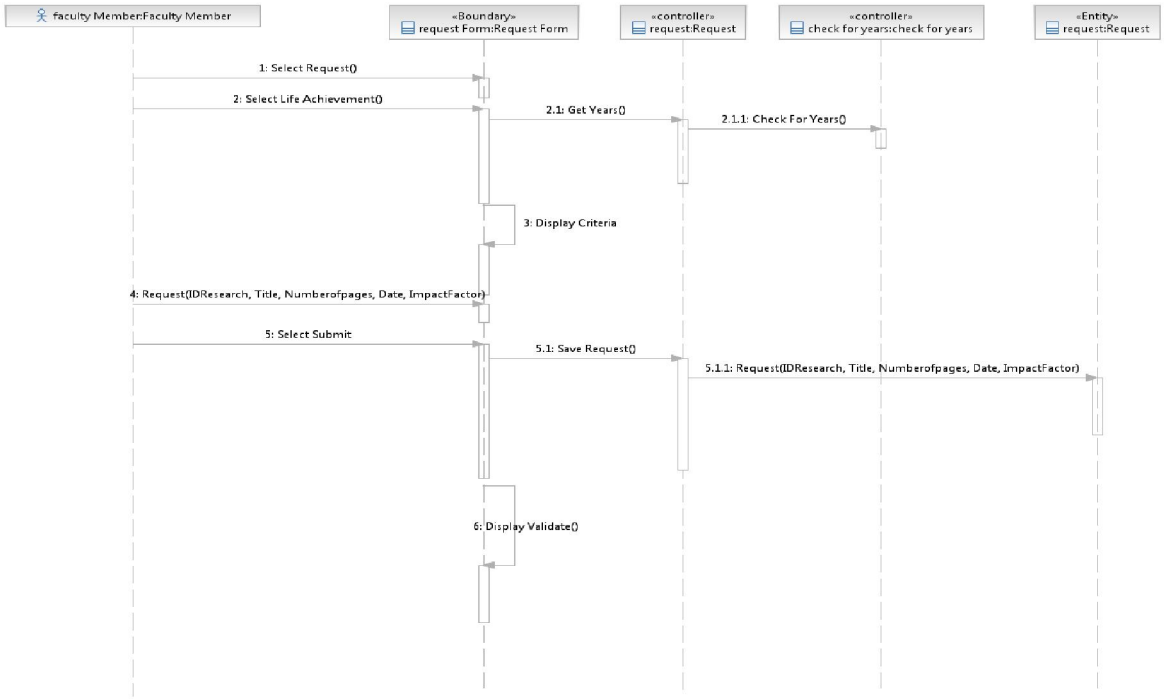

Figure 6. Sequence behavior of the patent, discoveries, and technology-licensing prize.

4. Related Work

Deploying an interactive web-based system requires a well-defined deployment approach and a consistent architecture design style. ULM provides a set of consistency models that support the application life cycle. In the following literature review, we describe the current research directions in UML-based development and deployment of web-based applications.

France et al. (2004) introduced a new technique that provides a pattern solution for modeling and designing using UML. The applicability of this proposed technique is validated by using the behavior of both observer and visitor patterns. A novel approach to modeling distributed and parallel applications has also been illustrated (Pllana and Fahringer 2002), in which the UML extension is utilized to deal with a distributed environment. Moreover, the message interaction and memory sharing of these systems was deployed and extended for large applications. Luján-Mora et al. (2006) introduced an extension of UML that is used to identify the conceptual level of multidimensional modeling in data warehouses. This extended model used object-constrained language (OCL) to formally define the rules that control model flow in consistent way. Hsu et al. (2014) presented a new model-driven approach to integration with a UML profile in order to visualize the internal structure and behavior of the application by providing Xlink documents, which enable the design to perform the quality criteria. Lee et al. (2014) adapted the domain architecture of the system to handle both function and non-function requirements. Both the domain components and architectural tactic semantics are produced to construct the domain architecture. Scanniello et al. (2014) introduced a practical and experimental approach to understanding the source code through requirement analysis and the output as a set of UML models that reflect the requirements. The relationship between model-driven engineering (MDE) and UML has also been explicitly defined (Hiltebeitel et al. 2013).

5. Conclusion and Future Work

In this paper, we proposed and discussed the design of a new framework for dynamically deploying applications based on UML analysis and design models. The proposed framework structure is composed of the following components: the KSU-ASE branches as subsystems, the KSU-ASE Board Committee, nomination processes, and evaluation criteria. The objectives and embedded rules and behavior for each component were introduced. Moreover, the interactions between the framework

components were introduced in terms of framework logic behavior.

This paper illustrates the usage of the proposed framework and its applicability, using a real-life case study obtained from the King Saud University Scientific Excellence Prize system. In our future work, we plan to enhance the quality of service itself by applying additional measurements. Moreover, we plan to use UML/OCL to formalize the system constraints.

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Corresponding Author:
Dr. Abdulhameed Alelaiwi
Department of Software Engineering
College of Computer & Information Sciences,King Saud University
E-mail: aalelaiwi@ksu.edu.sa

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