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Proposed Model for the Construction of the University of Al-Balqa' Applied e-Learning System Using Web Engineering Standards

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Abstract*:* This paper aims to use web engineering to establish a suitable e-learning development strategy for the Al-Balqa' Applied University. A learning management system is crucial for teaching and learning, and with technological improvements, e-learning is becoming the norm in every country. As a result, developing and upgrading e-learning technologies to aid the educational process and improve students' learning experience is critical. The Al-Balqa' Applied University adopted Moodle as its primary e-learning system. As a result, the proposed e-learning system's web application development will be based on Moodle. Web applications will take a two-stage approach: the first stage will be analyzing the current application to gain a complete understanding of the requirements for developing the e-learning system at the Al-Balqa' Applied University, and the second stage will be converting or translating these requirements into the proposed model based on the WebML method, which has seven steps.

Keywords: *Web Engineering, e-learning system, WebML method.*

1. Introduction

In our educational world, the use of information transfer technology is one factor that affects the development of the educational process. It led to new challenges to education and training systems and the search for technical methods to enrich the educational process. There is no area of knowledge left unaffected by the winds of technological and cognitive change since technology plays an integral part in everything we do. While technology was confined only to science, it has now permeated every facet of human endeavour.

In contrast, the Web reaches the "world" [1]. The widespread use of computers in all fields has already begun to erode the influence of computing specialists on how computers should be utilized. The Web has brought computing to a larger audience and now encompasses far more individuals than computing experts have ever worked with before. The allure of the Web, along with the ease of access to programming tools, has resulted in a proliferation of websites and applications built by end-users rather than computing specialists. On the other side, the increase in end-user computing raises questions about the quality and reliability of online applications[2].

Whether used inside an organization (INTRANETS), across several organizations (EXTRANETS), or over the Internet, traditional programmers are designed for a smaller user base than web-based applications. On the other hand, web application developers may be unfamiliar with all their users. Additionally, they must keep up with quickly changing technology and developing standards, be cognizant of legal and security concerns, and create visually pleasing websites and pages. These realities prompted the creation of a multidisciplinary Web engineering area to fulfil the demands of an ever-expanding worldwide distributed e-commerce industry.

The practice of web engineering is a subset of software engineering that defines processes, technologies, and models appropriate for the web environment to produce high-quality results. According to[2], web engineering encompasses several concepts, including software engineering, hypertext architecture, requirements gathering and analysis, system design, web application development and maintenance, methodologies, techniques, tools, and transformation from one form to another Figure (1).

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As[3], Stated that real-time application development on the Internet depends on several factors, namely: testing new applications, verifying the new application, correcting errors in the new application and the tools used in the new application, quality assessment, monitoring and ensuring

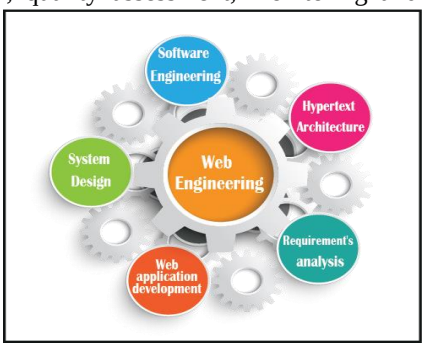

Fig. 1. Web Engineering Components

the safety of the latest application from errors and reformulating shapes and models in Website, project management, and evaluation forms for web performance. The development of the educational system is one of the most critical and urgent challenges facing contemporary societies. The trend towards benefiting from technological progress has become a general global goal to modernize and develop the educational process.

E-learning in the present era is one of the most prominent features of progress and advancement in societies, as it has become recognized that achieving the desire of any society to be a civilized and developed society depends primarily on the results of efforts to achieve the overall quality of the websites used by educational institutions. As crucial as e-learning is, the obstacles and variables it faces, most notably the student flow, the increase in costs, the stagnation of the educational system, and the lack of human and technological cadres.

The current e-learning systems at the Al-Balqa' Applied University require improvements in communicative features, interface usability, mobile features, and testing standards, among other things. As a result of the various education stakeholders and their teaching techniques, the diversity of needs, and web usability, the e-learning system necessitates a more comprehensive and deep requirements engineering approach. Nonetheless, the e-learning system has numerous problems[4]. For example, several technical issues were identified during quick interviews conducted by the researcher with specialists working at the e-learning centre, such as problems with submitting assignments, issues with designing and posting tests, issues with the tests' timer, problems with broadcasting lectures, and other related matters that will be highlighted and analyzed further during the study. These issues must be addressed when developing a Web application, including scalability, performance, requirement engineering and security[5]. has been mentioned. There are four attributes/dimensions that determine the quality and explain the extent of learners' active and lively involvement in learning activities on the e-learning systems:

- **Interactivity**: This is how much an e-learning system lets people interact with each other and how well it responds to learning activities.
- **Engage ability**: This attribute includes UX qualities that stimulate user engagement in an e-learning system. It deals with users' feelings of being involved in and immersed in systems they are interacting and learning with. The learning process will be affected by how much and actively the learners participate in learning activities.
- **Audacity**: This quality involves all playful or fun activities to stimulate or motivate learning.
- **Sociability**: This quality includes the factors that deal with how an e-learning system mediates between learners as these learners interact through the platform with other learners.

There is a pressing need for disciplined methodologies and innovative methods and tools for developing, deploying, and assessing e-learning systems to achieve better quality and success in creating and implementing complex e-learning systems. Notably, such techniques and methods must take into consideration **1)** the unique characteristics of the new medium, **2)** operational contexts, **3)** scenarios and a wide range of user profiles, as well as **4)** the kind (and skills and expertise) of individuals who create e-learning systems, and **5)** the quality of e-learning systems, e-learning application development has additional hurdles because of these factors. Thus, web engineering involves creating, implementing, and maintaining high-quality e-learning systems and applications via scientific solid, technical, and management concepts and disciplined and systematic techniques.

Thus, the current study aims to identify the current e-learning system the Al-Balqa' Applied University and then present a proposed model to develop this system using web engineering, given the increasing need for e-learning considering the prevailing conditions and the increasing technological development. Therefore, developing and improving e-learning platforms to support the educational process and maximize student benefit became necessary.

2. Problem Statement

With the significant development of electronic means of education, some educational institutions still suffer from shortcomings in the distance educational process due to the weakness of their electronic educational systems. Additionally, the absence of a single interface that enables the use of different contemporary tools, such as mobile phones and display screens, the lack of effective contact

with students, and the educational process's inability to produce the intended outcomes are all contributing issues.

3. Importance Of the Study

The significance of this study stems from the rapid spread of knowledge because of electronic development, which necessitated the development of educational systems that support the whole education system and aid in accelerating the educational process and improving its outcomes at the individual level. From here, discussing methods for developing electronic learning sites and identifying students' difficulties is necessary. Through this expertise, it is possible to begin laying the groundwork for an electronic educational system based on advanced technology. It contributes to the enrichment and facilitation of scientific material simultaneously.

4. Methodology

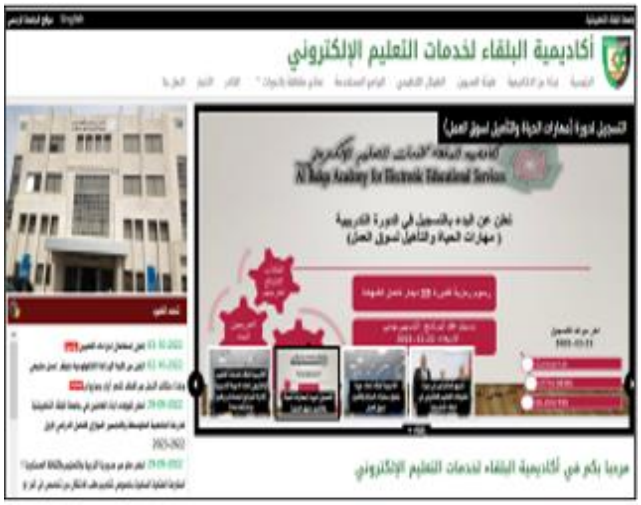

Fig. 2. The University of Al-Balqa' Applied e-learning Portal.

The researcher followed the inductive method by following the terminology, models, processes, and mechanisms related to the research subject and many previous studies. First, the deductive method was utilized to define the requirements for developing the web system. Then their needs were converted into phases and activities and finally into the suggested model in the study topic.

Al-Balqa' Applied University (BAU) is a government-supported university located in Salt, Jordan, and was founded in 1997; a distinctive state university in the field of Bachelor and Associate Degree Applied Education, with a capacity of more than 21,000 students distributed into 10,000 at the bachelor's degree programme and 11,000 at the associate degree program. Balqa' Applied University' BAU has 18 branches divided into six faculties at the main campus in Al-Salt and 12 faculties around the kingdom. BAU has a faculty in every Jordanian governorate. In addition to being a centre for higher education, the BAU oversees 38 public, private, and military community colleges all over the kingdom.

According to[6], The University uses Moodle as an e-learning platform and a learning management system, among other things. Immediately after the launch of the LMS website, a screen like the one shown in Figure (2) will appear, requesting users' login credentials. At the Balqa' Applied University' BAU, there are five different types of LMS users, each with its responsibilities: creators, administrators, editing instructors, non-editing instructors, students, and visitors.

The University of Al-Balqa' Applied e-learning system was utilized as a paradigm for developing web engineering tools in the present research.

5. Study Procedures

The researcher followed the following steps in preparing the current study.

1. A review of previous studies related to the subject of study, including website development methodologies, e-learning systems development and enhancement fields, web engineering, challenges facing organizations for developing systems, quality management for e-learning systems, requirements for building systems, and identifying methods, models, and approaches used to create e-learning systems.
2. Examining the literature to discover the ideas and models used to create and administer e-learning systems by people or organizations, then comparing those findings with other researchers' findings.
3. Criteria for e-learning systems administration and development that have not been addressed in prior research are defined as fundamental requirements for e-learning systems creation and management. Phases of these criteria were created, and each stage includes a series of tasks that must be completed before going on to the next step.
4. Transform the requirements into a model representing the stages and special activities in the site-building conditions the researcher has reached.
5. Study the model's applicability to all types of systems, including all organizations that want to build or develop e-learning systems on an ongoing basis.
6. They are discussing the benefits of the proposed model and its role in assisting the administration of the e-learning systems at the Al-Balqa' Applied University in developing and managing an e-learning system and helping institutions that wish to build their sites to adopt the proposed model.

6. Literature Review

6.1. E-learning systems

The tremendous development in computers, informatics, and communication technology led to a technical revolution that affected the sources and management of information in terms of quantity and quality. Nevertheless, electronic content does not necessarily mean the ability to benefit from contemporary informatics and its technologies. Any electronic content needs effective management to save, categorize, operate, and retrieve. When it comes to learning management systems, [7]. Defines them as programmers that manage events or situations related to the teaching and learning process, whether learners or teachers issue them. They also serve as platforms for directing and interacting with the processes of electronic learning situations and events.

Challenges to Students

frequently face a variety of hurdles and issues when implementing e-learning activities. Students must have the required technology and abilities to access online content properly. Some students may lack experience and confidence when it comes to using technology. Students face problems to deal and downloading Complex web pages or multimedia content. Human-Computer Interaction HCI aims to enhance user-computer interactions by making computers more usable and responsive to the user's needs. In the case of e-learning, the exchange quality is critical, as it directly impacts the learning process by enforcing specific communication styles [8]. However, users frequently perceive the technologies used as unfriendly, "vague," and distant, lacking much of the informal social interaction and face-to-face touch found in traditional classroom training; this is undoubtedly one of the main arguments used by e-learning critics [9]. Inexperienced computer users are particularly susceptible to these limitations, but even people who work in the informatics sector daily may be affected. Additionally, there is a lack of studies dealing with students' challenges to using e-learning systems from a web engineering viewpoint, which is the core basis for establishing electronic systems.

Challenges to Instructors

Due to the complexity of e-learning platforms, one of the most significant issues for instructors is the time required to deal with e-learning needs. Some instructors cannot create online courses due to a lack of knowledge and training, while others lack the confidence to use technology in the classroom. Instructors must adapt and rearrange their courses to meet the demands of online learning [10].

Challenges to Institutions

Implementing e-learning in higher education institutions raises several financial and strategic concerns. Financial constraints force organizations to find sufficient funds to build and maintain appropriate facilities, provide static technical support, fund training classes and hire qualified personnel. Many organizational changes are required within schools to implement or accept an e-learning environment, including staff organizational integration, flexible student offerings, and new teaching approaches. These developments place additional demands on working methods, particularly for online instructional designers and web programmers. Recruiting specialized and skilled employees to create high-quality e-learning content is challenging for many institutions due to the limited functions available through current e-learning platforms.

Moreover, during my work at the e-learning development centre, I noticed that there are some technical problems in the current e-learning systems, such as error messages, system suspension and the need for fast Internet to access some resources or perform some tasks; all these issues could be fixed using web engineering tools. Accordingly, I conducted quick interviews with some instructors and students to identify and solve the existing problems. It became clear to me that there are additional problems, such as a problem in test management and situations in the scoring system, where these issues arise from technical malfunctions. Thus, there is a pressing need to deal with these problems and sort them out to ensure a successful online learning process. This could be achieved by customizing the current e-learning systems to improve the deficiencies the instructors and educational institutions identified.

Furthermore,[4]. Believe that e-learning systems are among the essential e-learning options for universities and educational organizations. It is software that automates the management of teaching and learning activities in terms of courses, interactions, exercises, and tests. There are concepts associated with e-learning systems, such as:

- **CMS** - Course Management System.
- **LCMS** - Learning Content Management System.
- **LMS** - Learning Management System. Education Management Systems.

E-learning programs are divided into commercial programs and open-source programs, which are free. The users give this money to commercial companies in return for ongoing support for these programmers through the network, which the commercial enterprises supply. The open-source programs are subject to development and modification, so any user can add or change them. Table 1 below shows a brief and basic variation and differences between the most famous e-learning systems on the essential components and tools.by Gil-Vera, Puerta-Lopera (2020)[11].

6.2. Web Engineering

In web application development, web engineering is a technique of collecting and organizing information about web application development and applying that knowledge to designing web applications or resolving new needs or problems[12]. A method for coping with the complexity and variety of web-based applications is also known as web software architecture (WAA). The web-based system is a living system because it constantly changes, develops, and adapts, much like a garden. Therefore, a robust infrastructure should be in place to allow for a web-based application system's regulated yet flexible and consistent growth[13]. Web engineering is a valuable resource for creating an architecture that provides for developing and maintaining a Web system while enabling innovation.

Web engineering is the disciplined and methodical application of scientific, engineering, and managerial principles to create, deploy, and maintain high-quality web-based systems and services (K. Wakil et al., 2017). As [13]stated, "web engineering" is a comprehensive and reactive approach to developing massive web-based systems that try to regulate the present chaos in web-based system development, reduce risks, and improve the maintainability and quality of web systems.

Web engineering has grown in popularity among web-based system stakeholders, including developers, clients, government agencies, consumers, researchers, and academics, since its inception and introduction as a new discipline in 1998. Additionally, this new subject has drawn professionals from adjacent fields such as multimedia, distributed systems, software engineering, computer science, and information retrieval.

6.2.1. The development of web engineering

The rapid use of the Web for developing software applications and communication, education, entertainment, and commerce has drastically altered the software development environment. Traditional (pre-web) applications had a well-defined life cycle in which evolution and maintenance were measured in years, end-users were well-known and often captive, and interface and interaction concerns were not decisive; meanwhile, the Web presented a new set of obstacles. The needs of web applications change rapidly; they must cope with millions of unknown users who access millions of data items and demand tailored content and functionality. These users are rarely loyal, and they demand applications that are simple to use and effective.

The creation of the Web Engineering field was the first to strive to address the messy growth of Web applications. Thus, using systematic, measurable, and disciplined techniques to create, operate, and maintain web-based applications has been characterized as web engineering[14].

6.2.2. Web Development Process

The web development process outlines all the different steps and activities that go into building a website. To be effective, a set of procedures must be clearly defined, and developers must adhere to them [15]. Web applications are challenging to develop because of the unique challenges, such as real-time interaction, changeability, complexity, and the requirement to provide personalized information. Furthermore, estimating the time and effort required to build a Web application is complex.

6.2.3. Web Engineering Methods for Developing Web

For developing web applications, several web engineering methodologies have been proposed. The following is a list of them [16]:

- **UML-Based Web Engineering UWE:** A model-driven Web application development technique focused on the usability of UML models. For the last ten years, UWE has been used to customize Rich Internet Applications and business Web applications based on the BPMN standard in Web applications in the business context (Business Process Modeling Notation). To describe the usage conditions and the design aspects, the technique exclusively depends on the UML profile. A five-model layout and movement between them aid UWE's creation: Models for presentation, content, process, navigation, and requirements are all included.
- **Web Modeling Language (WebML):** is a model-based method for planning and developing data-intensive network applications using a waterfall program procedure. The approach is divided into seven steps involving the software developer conceptualizing different aspects of web applications. The display, data, and augmented hypertext models are the three models that underpin this approach. Over the last ten years, the unique WebML technique has improved by incorporating early adopters in creating many parts of web applications and new application kinds.
- **RUX Method:** Another model-driven approach is the Rich User Experience (RUX) method, which focuses on constructing rich user interfaces or RIA modules the user uses. This approach offers a three-phase process triggered by creating three models: abstract, concrete, and final interfaces, to produce the final user interface.
- **Object-Oriented Hypermedia Design Method (OOHDM):** The OOHDM has also been improved for RIA construction. The proposed method improves the OOHDM interface paradigm by

using ADVs (Abstract Data Views), which describe all structural components of a rich user interface and present it hierarchically. In addition, the researchers looked at the use of ADV schemas as a metric for determining interface behaviour. ADV schemas are typically state tools that facilitate the expression of interface transformations resulting from user interactions.

- **Semantic Hypermedia Design Method (SHDM):** The Semantic Hypermedia Design Method (SHDM) is a Semantic Web application design method based on ontologies. All the web application modules are built using a three-ontology set, which comprises navigation (Description of application settings and navigational pathways), domain (Description of application data), and presentation (conceptualization of the websites).
- **Object-Oriented Web Solutions (OOWS):** is an OO-Technique-based model-driven approach to creating Web (2.0) applications.

7. Proposed Model

The researcher proposes a methodology - Web Modeling Language (WebML), suitable for developing all types of web systems; the WebML approach consists of seven phases, as shown in Figure (3).

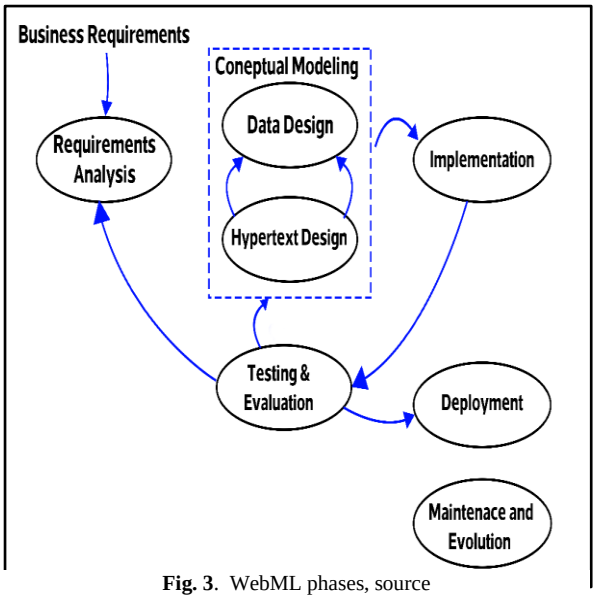

Fig. 3. WebML phases, source

The WebML approach consists of seven phases:

1. Requirement Analysis

The set of requirements that drive this activity's input is application development. Requirement analysis involves gathering information on the application domain and intended functions and describing them in simple terms. The preliminary results of this phase are as follows:

- Identify the target user groups; each group represents users with similar characteristics or perform similar functions in a business process, i.e., they carry out the same tasks and have access to similar resources. A single user may play several roles, making it possible for them to be a part of multiple organizations.
- Define functional requirements for the features that will be delivered to users. The appropriate tasks to be done for each category of users are determined and defined.
- In another sense, users can access, share, and modify critical information assets by identifying essential information objects.
- The breakdown of a Web application into site views are separate hypertexts meant to suit a specific set of functional and user needs. At least one site view providing the functions mentioned for each user group will be supplied.

The conceptual modelling process entails creating conceptual schemas that express the application's organization at a high level of abstraction, separate from implementation details. According to the WebML approach, conceptual modelling consists of data and hypertext design.

2. Data Design

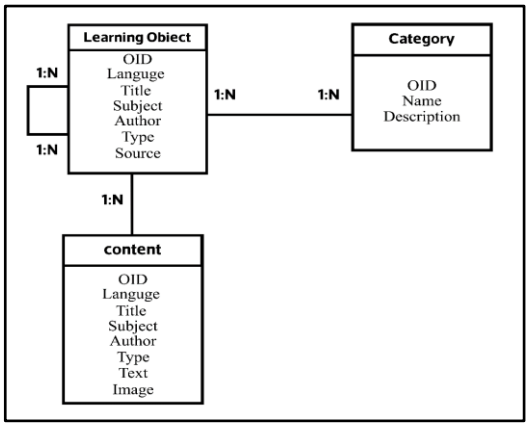

Fig. 4. A fragment of data schema of the e-learning system Web

Data design organizes a complete and cohesive data schema from the essential information items discovered during the requirements analysis that may be augmented with derived objects. The WebML data model comprises entities, containers for data objects, and relationships, which are semantic linkages between entities. Attributes are named properties that have a type associated with them.

Hierarchies may be utilized to organize entities, while cardinality constraints can be applied to limit interactions between those things. Figure (4) shows that the learning object entity represents learning object descriptions using characteristics based on the LOM standard. The attribute type describes various learning items the vertical application

provides (for example, lectures, lecture units, definitions, exercises, and exams). Every Learning object contains relationships with other Learning objects: a lecture unit, for example, may be linked to some relevant definitions, examples, exercises, or exams. The content entity then reflects the contents of learning objects (pictures, words, and files). The schema also contains an entity to make learning items more accessible. Stores are a category. Using ACM classifications, e-learning applications classify the learning materials they deliver.

3. Hypertext Design

On top of the previously stated data structure, hypertext design generates site view schemas. Site views describe the layout of information and services inside hypertext pages and component connectivity and navigation. For applications where distinct user groups conduct numerous activities or multichannel systems where users might use different access devices, hypertext design demands the creation of several site views addressing the user groups. Figure (5) refers to the pages where students can choose a lecture module and access its contents, including definitions, exercises, tests, and examples. First, users select a topic category (The Categories Page), then a course (Courses Page), then a lecture (Course Lectures page), and ultimately the lecture module they are looking for via a navigation chain (Lecture Modules page). The "L" marking next to Pages Categories and Lecture Modules indicates milestone pages. This feature implies that two pages will be accessible from any other page in the hypertext via landmark links.

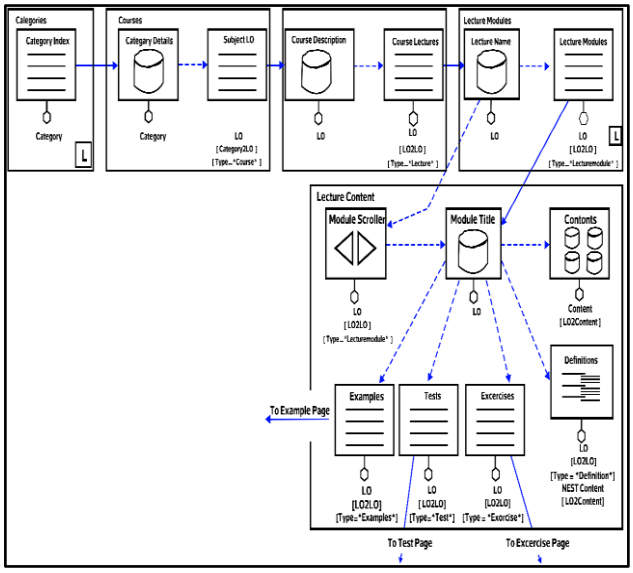

Fig. 5. WebML Specification for the Hypertext Interface for an E-Learning web Application

4. Implementation

WebML is used to develop applications with WebRatio, a commercial web application design and deployment tool. The WebRatio architecture comprises two layers: a design layer that allows users to change specifications visually and a runtime layer that provides essential services for implementing WebML modules on top of a regular Web application scope.

The suggested model uses two systems, which start with high-level abstractions and can automate application deployment. High-level notions such as entity and relationship are used to describe the content, whereas page, unit, and link express hypertexts in the WebML approach. WebRatio, a tool for automating Web application deployment, converts these ideas into implementation artefacts.

5. Testing and Evaluation

This phase entails testing and evaluating the application to enhance its external and internal quality, deploy it above selected architecture, and maintain and perhaps improve the program once deployed.

6. Development

In addition, the development encourages the use of novel methods for evaluating quality. This research has resulted in a system for automatically assessing the quality of web apps using models. At this phase, the framework supports static analysis (compilation time) of conceptual schemas and dynamic aggregation (runtime) of web user data to be immediately evaluated and related to the conceptual schema. The static analysis focused on identifying the conceptual frameworks of design patterns and evaluating them automatically against quality attributes stored as rules. On the other hand, Usage analysis entails the automated scanning and mining of enhanced weblogs, known as conceptual logs.

7. Maintenance and Evolution

The existence of an application's conceptual model also helps with maintenance and evolution. For example, requests for changes can be transformed into conceptual changes to the data model or the hypertext model. Then, changes are deployed for implementation at the conceptual level. Because modifications are only applied at the implementation level, this change management technique is readily integrated into the mainstream production lifecycle, lowering the risk of the software engineering process being broken.

8. Results

The study found that the new and proposed model is effective in developing and managing e-learning systems and helps to Manage Total Quality in managing and developing websites because old traditional methods do not follow a transparent methodology and steps in developing and managing websites, and this leads to problems in time, effort, and money in website development because it

depends on a specific team in Web development is like web page designers and programmers. However, the proposed model follows a web and software engineering methodology and uses active and static web development classes.

In conclusion, it can be realized that using WebML when building online applications would provide developers and consumers with a better understanding of the application's structure and design. Smaller businesses specializing in web development may find that building web apps is time-consuming and unnecessary. Furthermore, by modelling a web application, the institution may alter it to meet consumer needs before deploying it. Since the application is well-documented, it is easy for the institution to change it to meet new demands.

9. Recommendation

The researcher recommends implementing the proposed model since it will cause an increase in the quality of the Al-Balqa' Applied University e-learning systems and can be managed and developed continuously. Furthermore, this model was created to replace traditional paper-based procedures, which are inefficient and unmanageable as the number of papers grows.

The possibility of applying the proposed model for managing and developing e-learning systems in other the Al-Balqa' Applied University, where the model depends on seven successive phases, and each stage consists of straight activities to achieve quality requirements in website management.

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