Modelling and Implementation of Proactive Risk Management in e-Learning Projects: A Step Towards Enhancing Quality of e-Learning

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***Abstract*—The introduction of e-Learning to higher education institutions has been evolving drastically. However, the quality of e-Learning becomes a central issue in order to provide all stakeholders with the necessary confidence to compete with traditional learning methods. Risk management plays a vital role in the successful implementation of e-Learning projects and in attaining high-quality e-Learning courses. Little research has been conducted about implementing risk management in e-Learning projects. This work proposes a quality assurance framework for e-Learning projects. This framework comprises a proactive risk management model that integrates risk management into the e-Learning process. This integration helps in obtaining high-quality e-Learning courses by preventing negative e-Learning risks from being materialized. The model is verified to evaluate its effectiveness through a Renewable Energy Course that was converted from a traditional face-to-face into e-Learning course. Quantitative and qualitative measures are performed to analyze the data collected through the implementation of the project. The results show that the proposed model is managed to mitigate the majority of probable risk factors leading to high-quality e-Courses development and delivery.**

Keywords*—*e-Learning; technology-enhanced learning; quality; proactive risk management; risk factors; higher educatio

I. INTRODUCTION

The existence of many Higher Education Institutions (HEIs) today could be ascribed to their abilities to keep pace with the continuous technological changes. Some institutions feel overwhelmed by these changes. Some otherwise consider them as inevitable dimension to strengthen their competitive advantages. The major revolution in technology has been the evolution of Information and Communication Technology (ICT) in the recent decades. Indeed, the evolution is not in the technology itself but rather in its applications in knowledge, information sharing, and education. One of the most effective ICT applications is what is now referred to as e-Learning.

In its simplest definitions, e-Learning means doing learning activities electronically through the Internet [1]. It is considered a key part of distance education [2]. Some definitions restrict e-Learning to the delivery of the e-Content over the Internet. Broader definitions widen the concept to cover the interaction among participants too, delivered by different communication technologies, mainly the Internet [3]. This delivery could be fully online, or a hybrid approach that integrates electronic learning and traditional classrooms in what is so-called blended learning [4].

e-Learning has got through Higher Education (HE) drastically over the last few years. HEIs have recently recognized the importance of e-Learning in reducing operating cost and increasing students' satisfaction. Indeed, these issues are necessary but not sufficient for a university to achieve the desired competitive advantage. As quality has been playing an increasingly important role in the educational system [5], universities need to guarantee a high quality e-Learning to compete strongly.

Despite that e-Learning activities highly penetrate HE, quality of e-Learning has been an issue of debate. It was difficult to define what quality means to e-Learning courses. Several conceptual models and approaches rose recently, but the actual practice of quality of e-Learning in HEIs is still poor. Moreover, most of these approaches focus solely on the courses quality and the learning outcomes. Indeed, an overall detailed process-oriented quality assurance framework must exist and be followed during the e-Learning process to ensure the quality of the entire course, not only the output [6].

e-Learning projects deal with design, implementation, and utilization of social and information technological systems [7]. These systems involve several software applications (e.g. Learning Management System (LMS) and e-Content). However, there is no theoretical basis for project management that is specific to e-Learning [8]. Hence, most e-Learning projects management approaches follow software project management methodologies and inherit their characteristics because developing educational software shares several aspects with software development [9]. Mainly, it is the learning component what differentiates e-Learning projects from other types of projects [10]. Building upon this, the successful implementation of an e-Learning project requires balancing between project schedule, budget, and quality. Since the e-Learning process is mainly characterized by its quality, competitive universities should put the quality of the e-Learning projects at the forefront despite other challenges.

Both success factors and possible failures together should be taken into account to increase the probability of project success. These possible failures are called risks. An e-Learning project inherits all types of risk factors encountered in Information System projects beside many other risks that are specific to e-Learning [11]. These factors might negatively affect the quality of the e-Learning course being developed and/or the learning outcomes, project schedule and/or resources. Many risk factors are associated with e-Learning projects [12]. These factors can be personal or dispositional, learning style, instructional, situational, organizational, content suitability, and technological [13]. In order to minimize their negative impact, these factors must be managed carefully [14]. Successful management of e-Learning risk factors would improve the quality of the e-Learning process and, consequently, the competitive advantage of the institution. Hence, Risk management should be the core competence in e-Learning projects.

Risk Management is an important part in project management and very crucial for project's success. Indeed, this fact applies to all types of projects. Risk management involves predicting risks that might negatively affect the project schedule, budget or quality, and taking measures to avoid or mitigate the impacts arising from those risks [15]. Risk management in e-Learning projects could be defined as the set of principles, practices, procedures, methodologies, and tools aimed at identifying, analyzing and handling risk factors that could negatively affect the content development and delivery process and hinder the e-Learning project from achieving its desired outcomes. In e-Learning projects, risk management is a critical discipline that helps in reducing uncertainty, avoiding rework, improving content quality, making e-Learning process more reliable, decreasing learner's dissatisfaction and increasing the overall success chances. Several approaches to risk management exist. Reactive risk management does not apply mitigation strategies till the occurrence of the risks. Reactive risk management is expensive in terms of time and cost required to make necessary changes in the purpose of managing risk at the time of its occurrence. In contrast, proactive risk management provides information to stakeholders on how to best use resources to prevent the occurrence of unwanted events [11]. The latter aims at avoiding risks before they materialize; hence, it can be referred to as preventive risk management [16].

The best way to manage risks in e-Learning projects is to select the most suitable instructional design methodology and consider it during the development process as a mean to manage risks. Deciding upon the model that best fits a project is influenced by how risky the project is; the types of these risks and the degree to which each model supports risk management [17]. e-Learning projects are risky; they are vulnerable to several risks during the development and delivery phases. ADDIE (Analyze, Design, Develop, Implement and Evaluate) is the most popular well-known instructional design model. It is a prescriptive sequential instructional design model. Recently, opponents raise doubts around ADDIE model due to its strict linear implementation from the analysis phase to the evaluation [18]. Indeed, ADDIE e-Learning projects suffer from major risk factors that could not be handled using pure implementation of ADDIE. In ADDIE model, no feedback from stakeholders is incorporated until the last phase of the project [19]. Hence, the major risk factor is the late change in requirements. Any late change in requirements would either require a large amount of rework which would cost extra time and money [19], or it may lead to an unsatisfied user (i.e. low-quality process). Either case, project failure is inevitable. Another risk factor is that overlapping is not allowed, in other words, practitioners cannot move to the next phase until the previous phase is completely finished. Moreover, using ADDIE, no deliverables are made available to learners until the last phases of the project when all deliverables are ready [19]. Clearly, these factors will negatively affect the project especially if the project suffers from time contention. A recent trend is to abandon ADDIE and to move towards Agile approaches [9, 20]. Agile is a lean approach to project management that enables building releasable yet good quality products in short time periods [19]. Agile is an iterative [21], team-based, collaborative approach. At the end of each iteration, a working deliverable is made available to users, feedback from the users is sought at the end of each iteration and changes, if exist, are incorporated in successive iterations [22]. Moreover, iterations may overlap. Clearly, agile model avoids the major risks of the ADDIE model.

Risk management has not been extensively performed in e-Learning projects [11]. In e-Learning, the project mainly passes through two phases; content development and learning delivery. Risks need to be managed carefully during both phases so that the project can achieve its expected outcomes. To achieve its outcomes, an e-Learning project should guarantees a high-quality content and a high- quality learning. Assuring this, the project surely leads to the major outcome of the learning process; high-quality student.

Implementing e-Learning in engineering education is challenging. Pedagogy, infrastructure, policy, strategy, quality, and management are the major challenges [23]. However, modern technologies have ushered in an era of change in engineering education [23]. In Engineering education, e-Learning involves the use of ICT to deliver virtual classrooms, conducting laboratory experiments, administering Virtual Learning Environment (VLE), developing professional e-Content that is rich in animations and visualizations that are used to demonstrate material, concepts, diagrams, processes, circuits, components and functioning [13]. However, an adequate application of e-Learning in engineering education would facilitate the learning process and lead to high quality learning.

Despite being a developing country, Jordan has made great strides in the fields of ICT but with a humbling experience in e-Learning in HEIs. This is due to several barriers including resistance, technological infrastructure hinders, quality assurance issues and slow change of learning structures and processes. Hashemite University (HU) is a public university in Jordan. The experience of HU in e-Learning is not recent. However, all previous HU practices in e-Learning were blended learning; none of the offered courses were carried out fully online. Recently, HU started to recognize the importance of the fully online courses in reducing operating cost and

increasing students' satisfaction especially with the economic challenges, resources constraints and the geographical location of the university [24]. With all these in mind, the quality of the outcomes of the fully online learning process has become a major priority of the university. Hence, the need to develop, deliver and evaluate a fully-online pilot course was a necessity. HU has started to move towards online courses and several e-Learning projects have been started. HU intended to follow a quality framework in order to assure the quality of the e-Learning process and the outcomes of the e-Courses.

However, the literature lacks such a process-oriented quality assurance framework. Hence, in this paper, we propose a process-oriented quality assurance framework to ensure the quality of an entire course. This framework is risk-oriented; it embeds a proactive risk management model for managing e-Learning projects. According to the knowledge of the authors, the literature has not discussed how proactive risk management in e-Learning projects would enhance the quality of e-Learning courses. To validate this framework, a project was started in 2014 to develop and deliver a pilot course in Renewable Energy (RE). The course was first offered online in summer 2015-2016 then continuous piloting and monitoring were maintained over a period of 6 semesters. RE course was selected because it is a hot topic in Engineering, relatively advanced technical course, and never been developed and delivered electronically in the region.

This study aims at enhancing the quality of e-Learning in higher education by modelling and implementing proactive risk management in e-Learning projects. The main research issues that this paper aims to investigate are:

- To describe how proactive risk management can be implemented in e-Learning projects to enhance their quality.
- To identify the major risk factors associated with managing the implementation of an e-Learning project.
- To devise the major risk mitigation strategies associated with each risk factor.
- To compile a case study of an online course to collect and extract information about the applicability of e-Learning at HU.
- To describe how can we measure the quality of an e-Learning course.

The rest of the paper is organized as follows: Section II reviews related work. Section III introduces the proposed framework, section IV introduces an implementation of the model through the RE course, section V displays, discusses and analyses the results of the RE course evaluation and presents some limitations of this work, and section VI concludes the work and suggests future work.

II. Related Work

Several current projects and research aim at enhancing quality of e-Learning in HEIs. In [25], Bralić and Divjak proposed a blended learning model that integrates Massive Open Online Course (MOOC) into a traditional classroom. Their model was based on learning outcomes and used to evaluate the effectiveness of integrating a MOOC with classroom-based teaching. A model was proposed by Casanova and Moreira in [26] for teachers in HE to reflect and discuss the quality of Technology-Enhanced Learning (TEL) in their blended learning programs. They argued that HEIs need to be more critical with regard to the use of TEL, and to support it as a counterpart to traditional learning. The experience of the North Carolina Central University for an Introductory Biology course over four terms was discussed in [27]. In this research, Hollowell, Brooks, and Anderson discussed the impact of the application of quality course design standards on the design and student outcomes. Atoum, Al-Zoubi, Abu Jaber, Al-Dmour and Hammad [28] presented a new approach for delivering e-Learning courses in Jordanian universities. The researchers introduced a national quality assurance system for TEL that aims at improving, developing and implementing accreditation standards for quality assurance of TEL courses and study programs at a national level. English language course was implemented and delivered at a national level as a pilot study according to a strict quality assurance framework. In their project [5], Mazohl and Makl introduced scientific description of a practicable quality framework for blended learning. The proposed framework focuses on the quality of courses, the course itself, the quality in the organizations delivering blended learning courses, the learners' needs and the environmental conditions. Based on this framework, a pilot course was developed and tested at the University of Helsinki, Finland.

In [29], Gómez-Rey, Barbera and Fernández-Navarro explored the quality of the online learning experience based on the Sloan-C framework and the Online Learning Consortium's (OLC) quality scorecard. The researchers found that the OLC index has ignored the opinions of the learners in evaluating quality of online programs. Hence, they proposed an alternative way of measuring the quality of online learning programs using teachers and students' perceptions and satisfaction. Misut and Pribilova [6] proposed and verified a quality assurance method of e-Learning – ELQ based on Kirkpatrick model which includes four levels of evaluation: reaction, learning, behavior, and results. Ghislandi, Raffaghelli, and Yang [30] introduced an approach that takes into account the participants' engagement as insiders of a quality learning culture. In [31], Bremer described how the AKUE model could be used to improve the quality of e-Learning and the eContent development. The AKUE model involves four phases: analysis, conception, implementation, and evaluation. In [32] Ossiannilsson and Landgren introduced a conceptual framework to enhance quality of e-Learning in HE based on experiences from three international benchmarking projects. The framework suggests that various aspects of accessibility, flexibility, interactivity, personalization, and productivity should be implemented at all levels in order to meet students' expectations. In [33] Lin and Chen reported that a successful e-Learning system should take both system and information quality into account. They combined Technology Acceptant Model (TAM) with Information system Success Model (ISM) by considering system quality, quality of platform information, and course information. Sarsa and Soler [34] studied the relations among the variables of e-Learning quality by means of five conceptual

maps that ease the visualization of these relations. Marshall in [35] summarized the outcomes of multiple international e-Learning Maturity Model (eMM) assessments which aimed at improving e-Learning quality in the organizations.

Very simple trials in the literature have discussed the role of risk management in e-Learning projects. Vesper, Kartog˘lu, Herrington and Reeves [11] employed two risk assessment strategies in the formative evaluation of a task-based e-Learning program developed by the World Health Organization (WHO). The first strategy used an expert reviewer and the second used a risk assessment expert facilitator. Both strategies aimed at identifying probable risks early and controlling them. Reference [36] examined the students' risk perception while using the aLF. The aLF is a LMS that was developed by Spanish National University of Distance Education (UNED), Vázquez-Cano and García found that risks are concentrated in two dimensions: "basic risks" and "own and beyond students' circumstances risks". Barik and Karforma [1] presented the risks that might face different e-Learning system stakeholders. They also suggested tools and techniques to minimize those risks. The identified risks and techniques were related to integrity, security and reliability of an e-Learning system. In [3], Mahmud and Gope discussed several technological, psychological, socio-cultural and economic factors that would affect successful implementation of e-Learning in HE in Bangladesh. They concluded by recommending measures to resolve these issues with government and the private sectors.

In [37], Surcel and Reeiu presented a series of the problems of designing and implementing an e-Learning strategy, objectives, planning and didactic process management. They classified risks into risks associated to the professors and risks associated to the students. Finally, they proposed general controls to manage these risks. Allen and Hardin in [38] presented a model of management that encompasses the Instructional System Design (ISD) process. They also presented a process for evaluating the risk factors of the project and how to manage changes throughout the project that may threaten the project's success. Andersson [39] identified 37 major challenges for e-Learning in developing countries. The work used data from the eBIT program in the University of Colombo, Sri Lanka. These factors were discussed and solutions were suggested. Angelou and Economides in [40] presented a real-option methodology for controlling risks in e-Learning infrastructure business field and choosing the optimum ICT investment's deployment strategy. In [12], Ifinedo investigated the risks associated with implementing an e-Learning information system project in Estonia. As a rank-order list of the typical project risk factors encountered in this project was produced.

Despite that HEIs have recently recognized the importance of e-Learning in engineering education; few attempts were found in the literature. Bandaya, Ahmed, and Jan [13] discussed the application of e-Learning in engineering education. The research investigates e-Learning practices in the Engineering institutions of the state of Jammu and Kashmir as a case study. Rodríguez, Granados, and Muñoz [41] presented the intimate relationship between the e-Learning method and the studies of Engineering in Spain through teaching examples on several subjects of different Engineering studies. Benchicou, Aichouni and Nehari [42] reported the results of an empirical study that measures the readiness of HEIs in Algeria towards the application of the e-Learning in engineering education. An important barrier for implementing e-Learning in engineering education is the need for remote experimentations. Chandra and Samuel in [43] implemented a user-friendly system that allows students to carry out laboratory experiments from remote locations. Hence, despite the advent of e-Learning in all education fields, subtle improvements are required in the Engineering field.

In [44], Rooij and Williams stated that ADDIE is not enough for project management in instructional design and proposed research opportunities for closing the gap between instructional design education and practice.

III. Proposed Framework

Recent research discusses the influence of Software Engineering methodologies and practices over instructional design methodologies to provide high quality e-Learning [9, 20, 45, 46, 47]. In this proposed framework, two Software Engineering concepts were combined with the instructional design methodology. These two concepts are Risk Management and Agility.

In this research, the authors propose a framework for e-Learning projects that utilizes a proactive approach to risk management. Fig. 1 depicts an overview of the embedded model. This framework is risk-oriented wherein probable risks and risk factors are identified early and the whole development process is guided by the identified risks.

Typically, risk management process is integrated into the development and delivery process, and risks are avoided during the execution of the e-Learning process. In this framework, avoidance is imposed utilizing two aspects:

- First: adopting an instructional design model that best fits e-Learning projects
- Second: devising and implementing avoidance strategies that handle probable risk factors

In the proposed framework, a hybrid "Agiled-ADDIE" approach is used. Best practices from Agile is blended with ADDIE. e-Learning practitioners pass by all phases of ADDIE but with an order that is subject to continuous feedback from the different stakeholders. Using this approach, an effective collaboration and communication between all stakeholders, developers and learners is assured. This communication is the major constituent of Agile approach. The proposed framework consists of five stages: risk identification, planning, production, delivery and evaluation. These stages are:

- Risk Identification: In order to implement a proactive risk management framework, risk factors should be identified early before proceeding into the actual e-Learning development process. Hence, the first stage in this framework is risk identification stage. In this stage, the project manager sets a detailed list of risk factors that threaten the e-Learning project. This list is constructed based on project documentation, reviews of previous similar e-Learning projects, available checklists, and the project manager's experience. This initial list is refined later in the planning stage. Once the initial set of risk factors has been identified, they have to be managed. In this proactive framework, e-Learning practitioners proceed into the eContent development and delivery process phases, activities, risk mitigation strategies with an eye towards the identified risks and preventing them from being materialized [48].
- Planning: In this stage, the project is initialized; resources, risks and the course are planned. Team members are hired, tools are selected, budget and schedule are planned, sources of material are decided upon, and learners' analysis is carried on. The initial list of risk factors identified in the previous stage is refined here. Brainstorming sessions which involve all team members beside learners' analysis may come out with new important risk factors or may lessen the severity of any of the previously identified ones in the context of the project. Most importantly, a set of avoidance strategies is devised for each factor that mitigates the risk before being materialized. The devised strategies are practiced later in the proper phase of the project. Also, in this stage, the course objectives, outcomes, outlines and the assessment criteria are set. The organizational structure of the course and the basic unit of development (i.e. referred to as module) are also decided upon.
- Production: Developing eContent shares common aspects with software development, especially in the design and production stages [9]. Hence, Agility would be successful in this stage. The main goal of this method is to minimize the risk of incomplete or bad quality output. Using Agile, modules are produced iteratively. A module is produced at each iteration and enhanced in the successive iteration. Each module typically goes iteratively through the following phases:
- Design: In this phase, a set of learning objectives for each module besides the sequencing in which they should be achieved are formulated. The module outlines and the general look and feel of the module are created.
- Content preparation: In this phase, references and sources of information are selected, the material is collected and refined and the final content is written. The external support material may also be introduced.
- Storyboard design: A document is created in this phase that describes all elements of the final product including text elements, images, audio elements, animations, and interactions.
- Development: Interface layout and course outlines are created using the authoring tool. Media, interactive component, self-assessments, and quizzes are developed and then imported into the authoring tool.
- Publishing: The module is produced in a shareable format that can be handled by LMS in this phase.
- Review: The review in this phase is a formative assessment activity. Once the module is developed, and before it is delivered to the learners, a review should be conducted at the end of the iteration to ensure the quality of the module and continuous improvement. This review should mainly involve the Subject Matter Expert (SME) and the developer in order to make any required changes early in the successive iteration. Once the review has no negative feedback, then the module is ready to be delivered to the learner.
- Delivery: In this stage, the module is deployed into the LMS and made available to learners. This stage also includes managing and facilitating learners' activities such as virtual class-rooms, assignment, and quizzes. It is worth to mention that a module can be delivered even if others are not ready. This stage also includes quality assurance activities. During the delivery of each module, formative assessment is conducted. This assessment uses feedback from students during the learning process activities in order to evaluate the quality of the eContent, assess student's reception, improve weakness areas and strengthen the e-Learning course.
- Evaluation: Once all modules have been delivered and the course has finished, the course content and the instructional delivery should be evaluated. Feedback from students is used to perform the summative assessment. This assessment uses quantitative and qualitative analysis. Quantitative analysis uses students' satisfaction surveys to evaluate students' reaction towards the course and students' results and measure the knowledge they acquired through the course. Qualitative analysis uses interviews and open-ended questionnaires. The aim of the summative analysis at the end of the e-Learning course is to ensure that the course has achieved its expected outcomes and learning objectives and that the proposed risk management strategies have proven its effectiveness.

In real practice, the development stages described above remain applicable throughout all e-Content development projects. However, their differences emerge with regard to the anticipated project challenges and the proposed mitigation strategies.

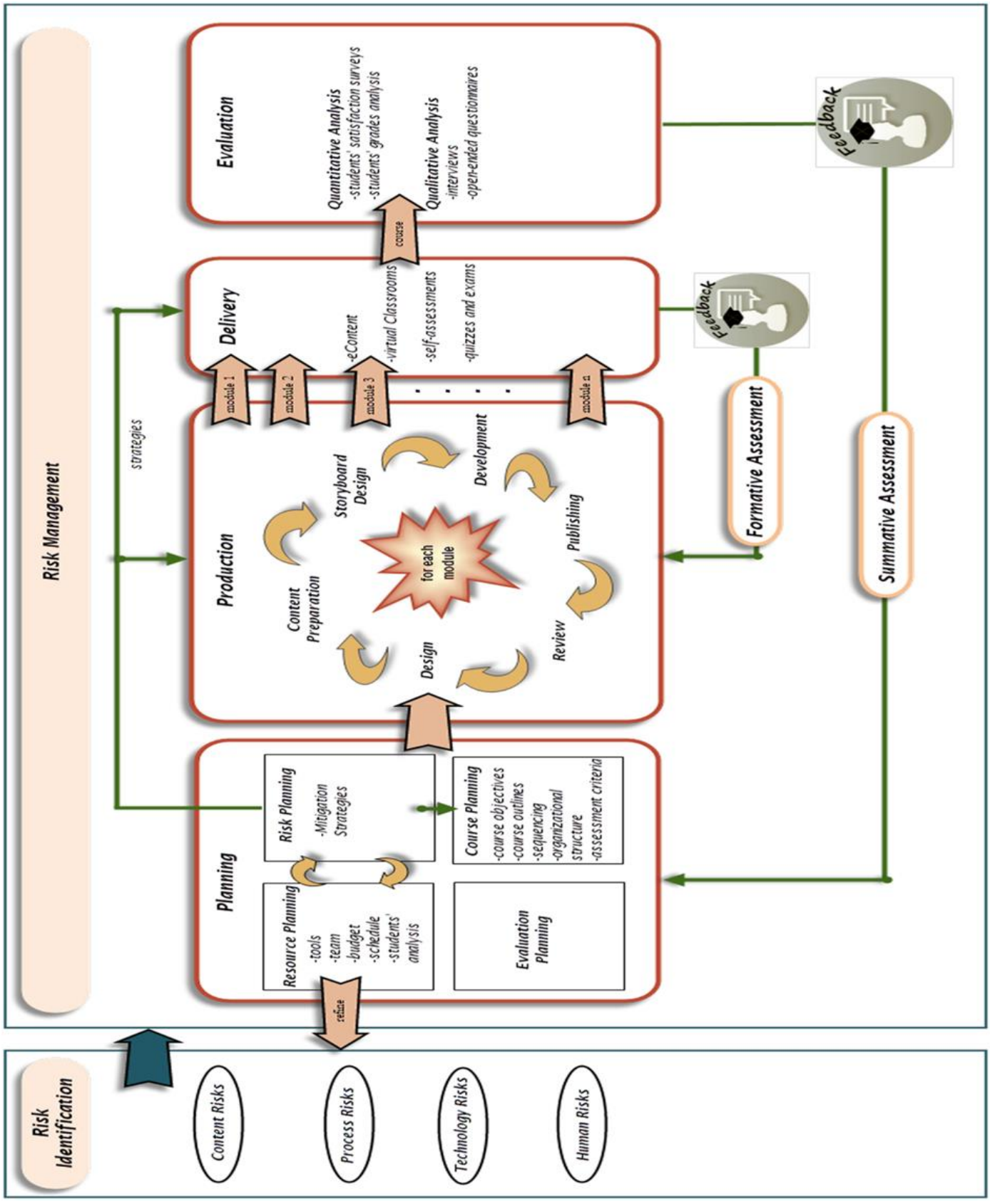

Fig. 1. The Proposed Proactive Risk Management Model for e-Learning Projects.

IV. Implementation of the Proposed Model

In order to validate the effectiveness of the proposed risk-oriented quality assurance model, one pilot course in RE was designed and delivered at HU. Continuous piloting and monitoring of the course have been spanning over six semesters in purpose of examining the comprehension of students. The project started in early 2014 and was first delivered on summer 2015-2016. The intention of the project was to create an e-Content that could be used efficiently by HU students in the online RE course. The course included static content, media elements, animations and interactive components to help students understand course topics via activities such as e-Content packages, exercises, design problems, self-assessments, quizzes, online assignments, peer discussions and virtual classrooms. All of these activities were hosted at Moodle LMS.

The RE e-Course was initially created for the undergraduate Mechatronics Engineering students at HU. The sample of the study consisted of 186 undergraduate students distributed on six semesters as in Table I.

Using the risk management method described above, the project team members were able to systematically and proactively identify risks related to RE course and determine various ways to reduce their effects. Due to the risk-oriented nature of the framework, the team used the framework as dynamic rather than static approach. The process evolves as new risks arise and other risks disappear. The following subsections describe in details how the various stages of the model were implemented during the development and delivery of the RE course.

A. Risk Identification Stage

In this stage, the project manager identified the major sources of risk (i.e. risk factors) that are specific to the RE course. An initial list of risk factors was identified through brainstorming sessions that involved all stakeholders. This list was refined later in the planning stage. The identified risk factors were categorized into four categories. These categories are content, process, technology and human risks. Content risks are those factors that are related to the courseware preparation, design, and development. Process risks are the risks that are involved in the course delivery and learning process. Technology risks are related to technological infrastructure of the online educational system including both hardware and software issues. Human risks involve risks related to the end users of the e-Learning course (i.e. students and tutors). A final refined list of risk factors is displayed in Table II. In this list, 43 risk factors were identified and categorized into the four categories. Each factor was given a number that uniquely identifies it (i.e. Risk Identifier (RID)).

B. Planning Stage

In this stage, the planning covers four dimensions; risks, resources, course and evaluation planning.

Risk Planning: A set of mitigation strategies were devised for each of the identified risk factors. These strategies, listed in Tables III-XI were defined to be practiced later in the proper phases. The strategies were proposed after conducting brainstorming sessions that involved all project team members. Each member was asked to employ risk-based thinking and devise mitigation strategies that would be used to manage the previously defined risk factors. Moreover, these brainstorming sessions came out with new information about the already identified risk factors. As a result, a list of refined risk factors was produced as shown in Table II. These factors were the harvest of the project managers' experience, team members brainstorming sessions, and predefined ready-made checklist and taxonomies.

Resource planning: involved planning of team and roles, tools, students' analysis, budget and schedule, and divided into the following three aspects:

- Team Building: Team members were hired, roles were identified and assigned. The team involved and instructional designer (ID) who is responsible for defining the instructional, delivery and evaluation strategies, SME; the source of knowledge and responsible for content preparation, e-Content developer who is responsible for developing media components, assembling course elements and installing the courseware onto LMS, course administrator who manages learners accounts, online tutor who supports and motivates students learning activities during the course, and a technical support specialist who provides technical support for all stakeholders during all phases.
- Technology Tools: A decision was made about the tools needed to be used to create and deliver the e-Learning content. We used Adobe Photoshop for creating bitmap images, Adobe Illustrator for vectoral images, Adobe Flash for creating animations, Trivantis Lectora as an authoring tool, Sony Sound Forge for sound file editing, Moodle as a LMS, SQL Server as a Database Management System (DBMS), Google forms for conducting surveys, Microsoft (MS) PowerPoint for making presentations and MS Word for creating tutorials and documents.
- Students Analysis: Students come to the course with different backgrounds, abilities and varying levels of understanding, computer skills and technical experience. Hence, the course should be designed in a way that satisfies the needs of all these students. Moreover, analyzing students' backgrounds may reveal new risk factors that could threaten the development process, or lessen the severity of other factors. For these purposes, a pre-survey was conducted in the planning phase. The results and the detailed analysis of the pre-survey are introduced in the following section.

TABLE I. Sample Distribution

Semester	Enrolled students
Summer 2015-2016	24
First 2016-2017	30
Second 2016-2017	31
Summer I 2016-2017	40
Summer II 2016-2017	28
First 2017-2018	33

TABLE II. RE COURSE PROJECT RISK FACTORS

Category	RID	Risk Factor Description
Content Risks	1	Course is difficult to navigate
	2	Course is unusable
	3	Content is inaccessible
	4	Content is rigid and not interesting
	5	Course is not visually attractive
	6	Lack of interactivity
	7	Difficulties to work with several types of media content
	8	Requirements change
	9	Inadequate educational resources
	10	Low quality media content
	11	Loading delay
	12	Lack of consistency
	13	Low quality content
	14	Course structure is not understandable
	15	Content is difficult to understand
	16	Student cannot identify what should he know from each module
	17	Use of foreign language
	18	Content developers are not familiar with the content domain
Process Risks	19	Content cannot be deployed into LMS successfully
	20	Timing and sequencing of activities are unclear
	21	Course does not fulfill its stated objectives and learning outcomes
	22	Inadequate assessment
	23	Unclear assessment policy
	24	Violation of assessment procedures
	25	Lack of direct face to face interaction with the tutor
	26	Students miss collaborative work
	27	Miscommunication between team members
	28	Delivery delay
	29	Poor technical assistance
	30	Unauthorized access
	31	Violation of law
	32	Students are confused about what and how to learn.
Technology Risks	33	Problems in Internet connection
	34	Unreliable technical, hardware and software infrastructure
	35	Browser incompatibility
	36	Large number of concurrent connections to server
	37	Student does not have computers
	38	Update and upgrade risks
Human Risks	39	Tutor is inexperienced in e-Learning technologies
	40	Tutor's resistance to online learning
	41	Students' resistance to online learning
	42	Students lack the required computer skills
	43	Non-interactive tutor

Course Planning: In course planning, high level objectives, course outlines, organizational structure, and assessment criteria were defined. The organizational structure of the RE course was hierarchal. The e-Content was composed of seven topics. The "Topic" is considered the basic unit of development. These Topics are: Introduction to RE, Photovoltaic Systems, Hydropower Energy, Geothermal Energy, Solar Thermal Energy, Wind Energy and Energy Economics. All topics are organized in similar ways. Each Topic is divided into sections and each section is divided into lessons. In order to evaluate students' knowledge and understanding of the material, it was agreed upon post assessment quizzes after each topic, mid-term and final exam. In addition, design projects were carried out online.

Evaluation Planning: It was decided to use both formative and summative assessments. Formative assessment was planned to be achieved through reviews conducted in the production phase and through feedback from students during the learning activities in order to collect information for the purpose of improving the e-Learning material being delivered. Summative assessment was decided to be at the end of the course in order to measure the effectiveness of the e-Learning process and the proposed framework. Most studies rely on user satisfaction or the acquired knowledge (or both) in order to evaluate an e-Learning process [49]. In this study, we use students satisfaction surveys at the end of the semester to find out how satisfied they are in the course and to make improvements based on their feedback. Moreover, students' final grades are analyzed at the end of the semester in order to measure the quality of the results and the acquired knowledge. Student's final grades consist of midterm and final exams in addition to the quizzes and projects taken during the course.

During each activity in each phase, the set of the mitigation strategies proposed in the planning phase are practiced cautiously by team members based on their roles in order to mitigate the negative effects of the corresponding identified risk factors. Lists of mitigation strategies to be practiced in each phase are introduced in Tables III-XI. Each strategy is uniquely defined using a strategy identifier (SID). Beside each of the identified strategies, the target risk factors IDs (TRIDs) that aim to mitigate are indicated.

For planning phase, a list of the proposed mitigation strategies involved in the planning phase is displayed in Table III.

C. Production Stage

The actual implementation of the e-Content was carried out at this stage. The development of the e-Content was accomplished module by module. Agile development was a major risk mitigation strategy to avoid requirements change and delivery delay risks as appears in Table IV. According to the framework, each module iteratively passed by 6 phases; design, content preparation, storyboard design, development, publishing, and review. The first phase of the production stage is the module design. A set of mitigation strategies were suggested in this phase in order to mitigate risk factors, these strategies are displayed in Table V. Once the module was designed, content preparation started. Several risk mitigation strategies were followed whilst preparing content in order to

mitigate risk factors. These strategies are depicted in Table VI. Creating storyboards is very important; they are themselves a mitigation strategy. The creation process also involves several risk mitigation strategies. These strategies are displayed in Table VII. In the development phase, the actual implementation of the courseware was carried on. The majority of content risks could be avoided by following several risk management strategies in this phase. These strategies are displayed in Table VIII. In the publishing phase, modules are produced in a shareable format to be handled by the LMS. The strategies that could be followed are displayed in Table IX. The last phase in the production is to test the courseware module and review it before it is delivered to students. The strategies that could be followed in this phase are displayed in Table X.

TABLE III. RISK MITIGATION STRATEGIES IN THE PLANNING STAGE

SID	Strategy	TRID
S1	Allocate a variety of software and development kit	7
S2	Ensure that the choice of software tools can easily support different file and media formats	7
S3	Use courseware authoring tool	7
S4	All tools are licensed	31
S5	Hire professional media specialists (graphic designer, animator)	7
S6	Team members are selected from university (insource)	27
S7	Leverage talents from the organization (i.e. university students) to help in developing media content	7
S8	Select a tutor with good computer skills and comfortable working online with students	39,43
S9	Provide training on how to make the best use of online facilities for e-Learning support	39,40, 41,42
S10	Training sessions on multimedia development	7
S11	Impose computer skills classes as a prerequisite for the course	42
S12	Breaking course into several modules (modular structure)	8
S13	Describe the general organizational structure of the course	14
S14	Assessment procedure is determined early in this phase	23
S15	Mid and final summative exams were decided upon as formal Assessment	22
S16	Quizzes are suggested to be used as part of the formal assessment process	22

TABLE IV. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE

SID	Strategy	TRID
S17	Agile development	8,28

TABLE V. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - DESIGN PHASE

SID	Strategy	TRID
S18	Objectives and outlines are identified before each module	16,32
S19	Objectives of the module should match the expected course outcomes	21
S20	Include a short description for each module	16
S21	Pre-quiz is selected as an evaluation strategy	16
S22	Self-assessment is selected as an evaluation strategy	21
S23	post-quiz is selected as an evaluation strategy	21

TABLE VI. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - CONTENT PREPARATION PHASE

SID	Strategy	TRID
S24	Instructional content relates directly to objectives	21
S25	Select material from high-quality textbooks and articles	9
S26	Use internal social media network to ask around for resource material	9
S27	Provide links to extra material	9,15
S28	Keep paragraphs short	5,15
S29	Use common formal language “i.e. English”	17
S30	Use simplest words and elaborations	15,17
S31	Integrate real-life examples and problems into the course	5,15
S32	There is a summary at the end of each module	16
S33	Glossary is used to define key terms and abbreviations	16

TABLE VII. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - STORYBOARD DESIGN PHASE

SID	Strategy	TRID
S34	Script is prepared jointly (i.e. content provider and content developer)	13,18
S35	Script describes the organizational structure of the module and exact table of contents	1,14
S36	Script should describe in detail media elements and desired interactions	13
S37	Do not include more than two paragraphs or 7 bullets items to a page.	5, 15
S38	Use bullets, tables, callouts, interspersed images to organize concepts	15,4,5
S39	Punctuation and capitalizations are used appropriately	13
S40	Avoid monolithic: chunk information into small pieces	15
S41	Rely on the power of interactivity	15, 6
S42	Employ humour to emphasize a point in relevant, light-hearted way	4
S43	Script lesson is proofread in terms of content by SME	13
S44	Script lesson is proofread in terms of language by language editor and word processor	13

TABLE VIII. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - DEVELOPMENT PHASE

SID	Strategy	TRID
S45	The eContent design allow student to pause and resume the course without losing their place	1
S46	Animations and navigational elements does not distract focus of attention	1
S47	Hyperlinks are clearly identified.	1
S48	All hyperlinks work and direct the student to the proper location	1
S49	Only reasonable hyperlinks and navigation elements are provided (students are not overwhelmed with hyperlinks)	1
S50	Hyperlinks are not introduced early at paragraphs need to be read completely or near important points.	1
S51	Navigation is allowed using “back” and “forward” buttons, table of contents, and navigation path.	1
S52	Navigation buttons are easily identifiable, and perceive a good level of affordance	1
S53	At any time student can identify his location with respect to course using a navigation path	1
S54	Develop a course map that enables student get an at-a-glance view of course content	1
S55	Clear instructions are designed to prevent possible runtime errors	2
S56	Course layout inspires student what to do in each page	2
S57	e-Learning activities are labelled and numbered in a way guides learners through the course.	1,2
S58	Error messages and direction are expressed in understandable language	2
S59	Needed information is provided on the same screen to minimize recall	2
S60	Horizontal and vertical scrolling is avoided	2
S61	Use icons related to actions	2
S62	Avoid colour combinations that are problematic for colour blind people	3
S63	Use large enough thick fonts	3
S64	Combine sound narration to highlight certain points or to provide certain comments on animations	3

S65	Use Alt tags to describe images	3
S66	Text is provided for all non-text elements	3
S67	Use Font colours visible against background colour	3,5
S68	(i.e. Main body text uses black font against white background)	3
S69	Main body text uses Sanserif font (i.e. Verdana)	3
S70	Avoid unnecessary colours, instead use bold and italic to emphasize	3
S71	Use appropriate line spacing	3
S72	Use play/pause to control sound	4,5,15
S73	Incorporate various types of multimedia (text, graphics, audio, video animations)	4
S74	Employ narrative storytelling	4
S75	Use appealing, simple, informative and helpful voice	4, 5
S76	Use bullets, tables, callouts, interspersed images	4, 6
S77	Use thought-bubble callouts that appeared alongside our content with characters' faces	5
S78	Balance between text and graphics	5,12
S79	Use decorative fonts only for headings	5
S80	Paragraph are justified	4,6
S81	Include quizzes with feedback at the end of each module	6
S82	Use of animations, navigations, and learning objects.	6
S83	Use of interactive infographics	10
S84	Sound files are recorded and edited in .wav format	10,11,33
S85	Use PNG format for images (i.e. lossless data compression format)	10
S86	Most animations have framerate of 24 fps	3
S87	No animations faster than 30 fps	10
S88	Animations narration sound files compressed as speech 22 kHz	10
S89	Animations use lossless compression PNG images	10
S90	Use text to speech software	12
S91	Use the same voice through different modalities such as videos, animations, infographics, text, etc.	12
S92	Each module has the same layout	12
S93	Keep fonts types and formats consistent through the course	12
S94	Do not use more than 3 fonts	12
S95	Overall design is uniformed	12
S96	Colours are used consistently	12
S97	Navigation is consistent throughout the course	12
S98	Animations and videos are consistent in quality, size and type	12
S99	Images are consistent in quality, size and type	31
S100	References are stated at the end of each topic	31
S101	Graphics, videos, animations, books copyrights reserved	33
S102	Make e-Learning content smaller	33
S103	Videos and images that require a high speed Internet are avoided	33

TABLE IX. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - PUBLISHING PHASE

SID	Strategy	TRID
S104	Publish module into sharable content object reference model (SCORM) format	19
S105	Publish illustration videos onto a YouTube channel	15

TABLE X. RISK MITIGATION STRATEGIES IN THE PRODUCTION STAGE - REVIEW PHASE

SID	Strategy	TRID
S106	Involve the SME and the developer in the review	13
S107	Test the content on different mobile devices	3
S108	Test the content on the most common browsers	35
S109	Testing was done with a student account	3, 30
S110	All combinations of assessments were tested	22

D. Delivery Stage

In the delivery stage, e-Content modules are made available to the learners and the learning process takes place. The list of strategies that could be followed to handle risk factors (mainly process factors) is described in Table XI.

TABLE XI. RISK MITIGATION STRATEGIES IN THE DELIVERY STAGE

SID	Strategy	TRID
S111	A help video was produced and its link is included on the main page.	1, 2
S112	Hardware and software requirements are identified early	3, 37
S113	Direct download links are provided for the required plugins (PDF reader, SWF player)	3
S114	Design a study guide and course syllabus	20
S115	Identify mandatory assignments and submission dates early	20
S116	Each module is given a sufficient time in the syllabus	20
S117	Feedback from students are sought periodically	21
S118	Assessment includes several types of questions	22
S119	Feedback is given for each question	22
S120	Assessments were challenging and realistic	22
S121	Every learning objective is assessed	22
S122	Exams, quizzes, graded assignments are clarified early	23
S123	Exams and quizzes were held online but not distant	24
S124	Exams and quizzes held at university lab (broadband connection)	33
S125	Quizzes questions and choices (if there is) were shuffled	24
S126	Quizzes and exams had “start and end time”	24
S127	Student names and login information are imported from university registration systems	24
S128	Conduct virtual office hours using synchronous tools (i.e. chat rooms, instant messaging)	4,6,25, 26
S129	Use asynchronous communication tools (i.e. email, forums, social networks groups)	4,6,25, 26
S130	Bulletin board is used for general announcements from instructors	25
S131	Assignments are submitted and graded with tutor feedback via Moodle	25
S132	Tutors are given administrative privileges regarding content management.	29
S133	Contact information of the technical support is given to both tutors and students	29
S134	Assign a separate topic in the discussion forum for reporting on technical problems	29
S135	Accounts were set carefully with privileges based on roles	30
S136	Only registered students are enrolled and can access the course	30
S137	Once the course is finished, all enrolment are cancelled	30
S138	Use firewall to control access	30
S139	References are stated at the end of each topic	31
S140	Assign a tutor that facilitates the learning process	32
S141	Technical assistance team	32
S142	Configure the maximum worker threads server configuration option	36
S143	Guarantee the availability of services using redundant Moodle server	34
S144	Regular data backups are taken from the course in case of a breakdown of certain components	34
S145	A high technical specification lab is dedicated to course access	34, 37
S146	Regular backup of the course	38
S147	Avoid updates or upgrades at critical times	38
S148	The version of the course is indicated	38
S149	Orientation day to motivate students to online learning	41,42

E. Evaluation Stage

Evaluation should be done at all stages; before the start date of the course, during the delivery, and after its completion. The post-course evaluation (i.e. summative evaluation) is the most important and the most challenging one. It is achieved by conducting a comprehensive survey at end of the course.

- Satisfaction Survey

At the end of the course, feedback from all project stakeholders was sought. The evaluation was conducted on two types of users, namely students and development team. Being the focal aspect of the e-Learning process, students' feedback is given a high concentration in the evaluation process. Students' feedback is very important. Throughout this feedback, students can describe their learning experience in the course. They can describe the content, material, activities, course design, delivery process, assessment methodology, etc. From their comments, pros and cons of the course are revealed so that they can be considered in the future to improve the design, deliverables and the delivery of the course. Herein, student's satisfaction surveys were used; a questionnaire-based approach that relies solely on students and how they were satisfied with the course. In this context, the main purpose of this questionnaire was to measure how the proposed framework and more specifically the proposed risk management strategies were effective in mitigating the identified risks. It was believed that if students exhibit high satisfaction towards the different course components, then the risk factors had been successfully managed by the proposed framework. Moreover, this questionnaire highly supports the internal quality assurance mechanism used at HU.

As mentioned before, post-course evaluation is the most challenging. This could be ascribed to two reasons. First, this survey should be comprehensive in a way that covers all key aspects of both design and delivery processes. The second is that this comprehensive nature of the survey would result in a quite lengthy survey that overwhelms students. In order to overcome these barriers and to encourage students to react to survey, the questionnaire was conducted online (using Google Forms) at the end of each semester. The questionnaire consists of 38 5-Likert scale questions (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The questions are formulated in a way that covers all risk categories and factors. The scale consisted of four subscales that measure course content, learning process, technology use, and people involved. Each question corresponds to one or more risk factors and measures whether each of these risk factors was mitigated well.

In purpose of evaluating students' satisfaction, the arithmetic mean score was used. The mean is the average of all responses for each item. The mean is often used to report central tendency of Likert items. It gives the best overall statistic of the typical rating given by survey respondents since it takes all data into account [50]. Mean score values above 4 are considered strong, between 3.5 and 4 are considered solid, and scores below 3.5 should be of concern [51]. Moreover, to measure the variability of students' responses, the standard deviation for each item was calculated. An item with a standard deviation greater than 1 indicates a wide variety in students' responses [51].

In order to ensure the comprehensive and the assimilation of students, the questionnaire was conducted among the students at the end of each semester to find out how satisfied they were in the course. Students' responses in all semesters are analyzed in the following section.

- Grades Analysis

It was believed that without measuring learning effectiveness, the quality of the e-Content and the e-Learning process could not be evaluated. Students' results and their grades were used as indicators of learning effectiveness and indicate the level of student achievement in the course. Student's final grades were drawn electronically from the university registration system. It consisted of the midterm, final exams, quizzes, and projects/assignments taken during the course. Exams and quizzes were administered to consist of good quality question items that cover all learning outcomes defined in the course. Moreover, information obtained from this evaluation can be used to enhance the pedagogical quality of the content.

V. Results, Analysis and Discussion

In this section, the results of the pre-survey that aimed at identifying new risk factors related to students or updating the severity of the already defined ones are introduced in details. More important, the effectiveness of the proposed framework in developing and delivering high quality e-Learning is verified based on satisfaction surveys and grades analysis. The results of implementing the framework in developing and delivering RE course in six semesters during the period 2015-2017 are introduced.

A. Pre-Survey

Students backgrounds were analyzed through a pre-survey that aimed at identifying other risk factors related to the learners. The pre-survey was conducted online and made available to the students via LMS. The pre-survey targeted a random sample of the Mechatronics Engineering students from different levels. A total number of 121 responses were collected. The pre-survey covered five dimensions: language and technical skills, e-Learning experience, feelings and doubts, hardware and software platforms, and disabilities.

Fig. 2 exhibits students' backgrounds and skills. When questioned about their fluency in English only 55 students (45.45%) said that they are fluent in English. This percentage would emphasize the "use of foreign language" risk factor. Regarding computer literacy, 83 students (68.60%) acknowledged that they have good computer skills. This fair percentage would also emphasize the risk factor "Students lack the required computer skills". A total number of 75 students (61.98%) used to access information from the web, 85 students (70.25%) feel at ease with online technology, 55 students (45.45%) used to use forums, and 52 students (42.98%) used to participate in chat rooms. The relatively low percentage of using forums and chat rooms would negatively affect students' interaction with the tutor and other students through the synchronous and asynchronous communication mechanisms.

Students were asked if they already had any e-Learning experience before, Fig. 3. Only 15 students (12.40%) enrolled full online course. More specifically, 48 students (39.67%) used forums in other courses, 39 students (32.23%) used chatrooms, 56 students (46.28%) practiced self-assessment program, 80 students (66.12%) practiced online exams, and 52 students (42.98%) used VLE to download material and resources. Overall, most e-Learning activities are practiced with a low percentage (excluding online exams) as appears in Fig. 3. This would negatively affect students' usage of course activities. Regarding VLE, 100 students (82.64%) had used Moodle VLE, and only 21 students (17.36%) had used a VLE other than Moodle. Hence, a decision was made to adopt Moodle as a VLE for this course.

Students also were asked about their feelings, doubts, and worries about the course, Fig. 4. A total number of 28 students (23.14%) preferred to take this course in a traditional classroom than totally online, 35 students (28.93%) were uncertain and 58 students (47.93%) preferred online delivery. From this, we can conclude that still there is some resistance from students towards online learning (i.e. risk factor). Deeply, 31 students (25.62%) were worried about the absence of the face-to-face tutor, 42 students (34.71%) were uncertain and 48 students (39.67%) had no worries about this issue (another risk factor). 29 students (23.97%) were worried about being isolated from other colleagues, 23 students (19.01%) were uncertain and 69 students (57.02%) were not worried. This fair percentage could be ascribed to the various currently available communication technologies which make this factor less severe. Moreover, 45 students (37.19%) were worried about the assessments and grading policy, 35 students (28.93%) were uncertain and 20 students (33.88%) had no worries. This would increase the importance of mitigating this risk factor.

Additionally, students were questioned about the hardware and software platform they have, Fig. 5. A total number of 115 students (95.04%) students have personal computers. This high percentage would eliminate this risk factor. Moreover, 51(44.35%) have windows 7 installed, 12 students (10.43%) have windows 8, 42 students (36.52%) have windows 10, and 10 students (8.70%) have other operating systems. Also, 40 students (34.78%) have 1-2 GB RAM and 75 students (65.22%) have RAMs larger than 2GB. Small size RAMs may negatively affect course navigation, delay playing media content, etc. 97 students (84.35%) uses Chrome browser, 5 students (4.35%) IE and 7 students (6.09%) Firefox and 6 students (5.22%) used other browsers. Accordingly, students use different Internet Browsers; browsers incompatibility is another risk factor. Regarding plugins, 109 students (94.78%) have a PDF reader installed on their pcs, and 55 students (47.83%) have a SWF player installed. This might prevent the student from playing animations and other media contents (i.e. risk factor). With respect to the Internet connection, 103 students (85.12%) have Internet connection 24/7. Among them, 28 students (27.18%) have up to 2 Mbps Internet connection, 49 students (47.57%) have up to 8 Mbps and 26 students (25.24%) has up to 16 Mbps. Problems in connection is a risk factor. Moreover, Low connection speed may cause loading delay (another risk factor).

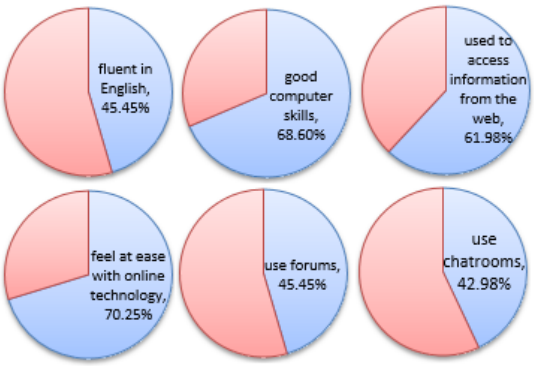

Fig. 2. Students' Backgrounds and Skills.

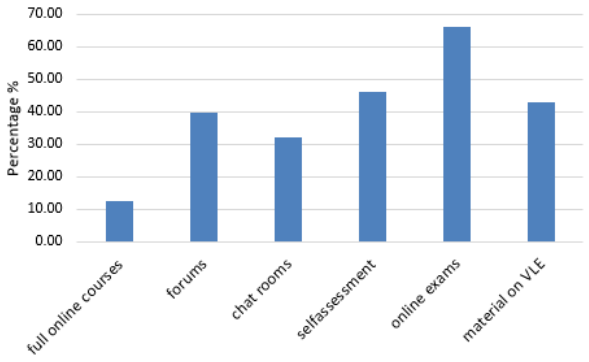

Fig. 3. Students' e-Learning Experience.

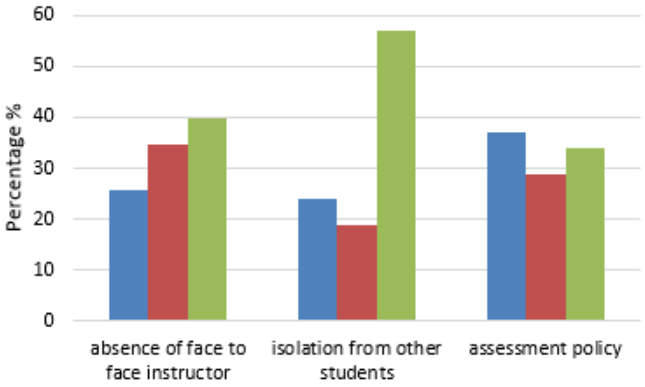

Fig. 4. Students' Feelings and Doubts.

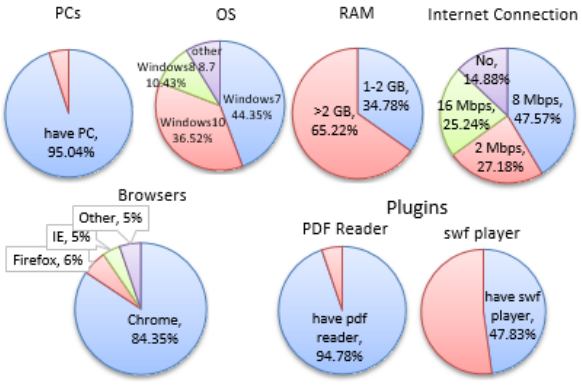

Fig. 5. Technical Infrastructure.

Lastly, regarding disabilities, 25.62% students have poor vision. None of them are either visually impaired, color blind, deaf or have movement disabilities. People with disabilities may not properly access the course (risk factor).

B. Satisfaction Surveys

Satisfaction surveys involve quantitative and qualitative assessments. Quantitative assessment targets the learners in purpose of measuring how satisfied they were with the course. Each quantitative assessment item is associated with a risk factor. Based on students' reaction towards each item, we can measure how the model and the proposed risk management strategies were effective in mitigating each risk factor. Qualitative assessment targets other stakeholders (i.e. mainly development team) to measure how specific-related risk factors are mitigated. Below, satisfaction surveys results are introduced based on risk factors categories. The last part of the survey (i.e. Global items) involves general question items to measure how students are satisfied with the course in general.

- Content Risks

1) Quantitative analysis: Concerning content risks (see Table XII), students reacted positively towards most items with a mean average value equals 4.0. Items 1-5, 7-11, and 13 have mean values greater than or equal 4, then, according to [51] these responses are described as "strong". Items 6, 12, and 14 have mean values between 3.5 and 4 then they are considered "solid". In order to assess the variety in responses, standard deviation was calculated for each item. As appears in Table XII, all standard deviation values are around 1 which indicates little variations in responses. Moreover, the most frequent answer for all items were either Strongly Agree or Agree (mode =5 or 4). This implies that content risk factors were mitigated very well. The solid mean values for items 6, 12, and 14 indicates that risk factors 6, 15, and 17 were mitigated but special attention should be paid in the future to increase students' satisfaction towards items 6, 12, and 14. In other words, new mitigation strategies should be followed to increase course interactivity and simplify the content and language. From another point of view, low values in language simplicity could be due to students' low fluency in English language in general (only 45.45% of the students said they are fluent). Moreover, the loading delay encountered could be ascribed to the relatively low Internet connection speed (74.75% of department's students have download speeds up to only 8 Mbps).

2) Qualitative analysis: Regarding risks 7, 8, 9, 18, and 19, development team were enquired to assess how these risks were mitigated. They said that they faced no difficulties in working with different types of media content due to the availability of tools, professionals and the training sessions they had. When questioned about the requirements change, they reported that they had few challenges since the content was implemented incrementally in iterations with a continuous review with the SME; changes were adopted early. Content developers reported that they had very few difficulties in collecting material; they employed social networks, and used high quality books and web links to write high quality content. When asked about their familiarity with the domain, content developers said that they are unfamiliar with RE domain but they could overcome this risk by preparing the script jointly with the content providers and SMEs. Developers also reported that they had no problems in deploying the e-Content into the LMS since they had published into as shareable format (i.e. SCORM). Hence, also risk factors 7, 8, 9, 18, and 19 were mitigated successfully.

- Process Risks

1) Quantitative analysis: Regarding process risks (see Table XIII), with mean values greater than 4, students exhibited strong satisfaction towards items 15-26 (except 22) regarding feel of isolation (item 22), a solid mean value of 3.8 was obtained. Indeed, 70.37% did not feel isolated from other colleges which is slightly larger than the (57.02%) who were worried about this issue before taking the course. More mitigation strategies should be taken to increase this percentage. The items mark little variances since almost all items values are around 1. Also, the mode was either 4 or 5. This implies that risk factors 20-26, 28-29, and 31-32 were mitigated very well.

2) Qualitative analysis: Concerning risks 27 and 30, development team were enquired to assess how these risks were mitigated. They said that they faced very little communication problems because they all work in the same institution (i.e. HU). Regarding access authorization, they said that they did the testing using student accounts to make sure that they are given the right permissions. Hence, also risk factors 27 and 30 were mitigated successfully.

TABLE XII. STUDENTS' SATISFACTION SURVEY RESULTS - CONTENT RISKS ITEMS

Item	Description	Mean	SD	Mode	TRID
1	I was able to navigate the course easily	4.1	1.1	5	1
2	The course was easy to use	4.1	1.1	5	2
3	I could easily access course content and activities	4.3	1.1	5	3
4	The course was interesting	4.1	1.2	5	4
5	I liked the design of the course	4.0	1.1	5	5
6	The course was highly interactive	3.8	1.0	4	6
7	Media (images, sounds, animations, videos) quality was high	4.0	1.1	5	10
8	There was no large delay in loading media elements	4.0	1.1	5	11
9	Course design and components were consistent	4.0	1.0	4	12
10	The course was free of syntactical, grammatical errors and mistaken information	4.0	1.1	5	13
11	The organization of the course into units and subunits was clear	4.2	1.0	5	14
12	The content was easy to understand	3.9	1.0	4	15
13	The objectives and outlines for each module were clear	4.2	1.0	5	16
14	The language was simple and clear	3.8	1.2	5	17

TABLE XIII. STUDENTS' SATISFACTION SURVEY RESULTS - PROCESS RISKS ITEMS

Item	Description	Mean	SD	Mode	TRID
15	Timing and sequencing of topics and other activities were clear	4.1	1.1	5	20
16	The aims and objectives of the course were achieved	4.1	1.1	5	21
17	Assignments and exams were related to the materials taught in the class	4.3	1.0	5	22
18	Assessments were satisfactory	4.2	1.0	5	22
19	Grading criteria were outlined in the syllabus	4.4	1.0	5	23
20	Assessment procedure can NOT be easily violated (i.e. cheating, unauthorized access, impersonate, etc.)	4.0	1.1	5	24
21	I would prefer to take this course online rather than in a traditional classroom	4.0	1.3	5	25
22	I did not feel isolated from my colleagues	3.8	1.2	4	26
23	The unit's modules were delivered onto Moodle on time	4.3	1.0	5	28
24	The technical support for this course was effective	4.1	1.0	5	29
25	References and copyrights were declared clearly	4.1	1.1	5	31
26	I was able to know what and how to learn	4.2	1.0	5	32

- Technology Risks

1) Quantitative analysis: Regarding technology risks (see Table XIV), students reacted positively towards items 27-28 with mean values of 3.7 and 3.9 respectively (solid values) and an average value of 3.8. Also, the mode for both was 5. This implies that risk factors 34, 36 were mitigated very well. Regarding Browser incompatibility risk (factor 35), students were asked to mention the browsers they used to navigate the course. A percentage of 72.66% of students used Internet Explorer, 91.37% used Google chrome, 15.83% used safari, 10.07% used Firefox, and 24.46% used android Internet browser. Hence, the course could be viewed using different browsers; avoiding risk 35.

2) Qualitative analysis: Concerning update and upgrade risks (Factor 38), development team reported that they did not face any update problem since they did not perform any update or upgrade during the delivery phase of the course in order to avoid these issues. The vast majority of the students (as from the pre-survey) reported that they have personal computers which would eliminate Factor 37. Moreover, a computer lab was dedicated to facilitate students' access to course content.

TABLE XIV. STUDENTS' SATISFACTION SURVEY RESULTS - TECHNOLOGY RISKS ITEMS

Item	Description	Mean	SD	Mode	TRID
27	I could access the course even if the main server is down	3.7	1.13	5	34
28	No significant drop in performance occurs when large number of students access the server concurrently (i.e. exams)	3.9	1.12	5	36

- Human Risks

1) Quantitative analysis: Obviously human risks were mitigated well (see Table XV). Students reacted positively towards items 29-33 mean values above 4. Moreover, the most frequent answer (mode) for all items was Strongly Agree. This implies that the risk factors 39-43 were mitigated very well.

- Global Items

The last part of the survey (see Table XVI) reflects global measures that assess the overall satisfaction of the RE course project. Concerning global items 34-38, a percentage of 83.33% of students said that the course saved their time with a mean of 4.3. On the other hand, 68.52% said that the course saved their money with a mean of 3.9. 77.16% recommend other students to take this course online in contrast with only 47.93% who had preferred, in the students pre-analysis, to take this course totally online. Moreover, 73.46% would like to take other online courses in the future. Finally, overall, 83.95% were satisfied with the course in general with a mean of 4.2. This implies that students generally were highly satisfied with the course.

TABLE XV. STUDENTS' SATISFACTION SURVEY RESULTS - HUMAN RISKS ITEMS

Item	Description	Mean	SD	Mode	TRID
29	The tutor was experienced in e-Learning issues	4.1	1.01	5	39
30	The tutor was motivator and e-Learning supportive	4.2	0.97	5	40
31	I was motivated to take this course online	4.1	1.16	5	41
32	I already have the required computer skills	4.3	1.05	5	42
33	The tutor was accessible and prepared to teach the course online	4.2	1.04	5	43

TABLE XVI. STUDENTS SATISFACTION SURVEY - GLOBAL ITEMS

Item	Description	Mean	SD	Mode	Percentage
34	Taking the course online saved my time	4.3	1.1	5	83.33%
35	Taking the course online saved my money	3.9	1.2	5	68.52%
36	I recommend other students to take this course online	4.1	1.2	5	77.16%
37	I would like to take other courses online in the future	4.0	1.3	5	73.46%
38	Overall, I would rate this course Excellent	4.2	1.0	5	83.95%

C. Grades Analysis

In order to validate the effectiveness of the proposed model, the quality of the e-Content and the e-Learning process was evaluated. Students' grades were used as a measurement for the quality of the e-Course content and process. In this section, students' results along six semesters (during 2015-2017) of the electronic delivery of the course are introduced in Table XVII. In contrast, students' results along the preceding three semesters (during 2014-2015) of the traditional delivery

of the course are also introduced Table XVIII. Then, a comparison between the results of the electronic delivery versus the traditional delivery is introduced in Fig. 6.

Table XVII shows that the students achieved good results in the electronic delivery form of the course. In compare with the traditional delivery of the course, Fig. 6 shows that e-Course students performed similarly or even better in most categories. The percentage of students who failed in RE e-Course along the semesters was 3.76% in contrast with 9% in the traditional course. Moreover, the percentage of students who got high grades (i.e. above B) in the e-Learning course is slightly larger than the traditional. For instance, a percentage of 9.13% of students got B in the e-Course whilst only 4% got B in the traditional. Another percent value of 8.06% of students got B+ compared to 8% in the traditional. A percentage of 11.29% of online students got A- in contrast with 10% of the traditional, and 5.91% got A in the online, while 5% got the same mark in the traditional . These values indicate a high quality electronic course and therefore validate the effectiveness of the proposed proactive risk management model leveraged in the e-Course development and delivery.

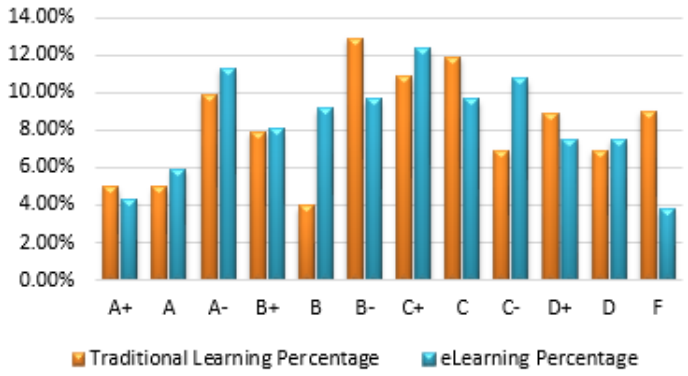

Fig. 6. e-Course Students Results Versus Traditional Results.

TABLE XVII. .RE E-COURSE STUDENTS GRADES

Grade	Range	Sum. 2015-2016	First 2016-2017	Second 2016-2017	Sum.I 2016-2017	Sum.II 2016-2017	First 2017-2018	Percentage
A+	90.00-100.00	2	2	2	1	0	1	4.30%
A	86.00-89.99	2	3	2	2	2	0	5.91%
A-	82.00-85.99	2	3	5	2	6	3	11.29%
B+	78.00-81.99	5	2	4	0	2	2	8.06%
B	74.00-77.99	2	6	1	4	1	3	9.14%
B-	70.00-73.99	1	3	6	2	1	5	9.68%
C+	66.00-69.99	3	4	3	5	4	4	12.37%
C	62.00-65.99	2	4	1	7	1	3	9.68%
C-	58.00-61.99	2	2	3	5	3	5	10.75%
D+	54.00-57.99	1	1	1	6	4	1	7.53%
D	50.00-53.99	1	0	2	4	1	6	7.53%
F	0.00-49.99	1	0	1	2	3	0	3.76%
Total		24	30	31	40	28	33	

TABLE XVIII. RE TRADITIONAL COURSE STUDENTS' GRADES

Grade	Range	First 2014-2015	Second 2014-2015	First 2015-2016	Percentage
A+	90.00-100.00	2	2	1	5.00%
A	86.00-89.99	2	2	1	5.00%
A-	82.00-85.99	5	1	4	10.00%
B+	78.00-81.99	3	2	3	8.00%
B	74.00-77.99	0	1	3	4.00%
B-	70.00-73.99	2	3	8	13.00%
C+	66.00-69.99	2	5	4	11.00%
C	62.00-65.99	2	3	7	12.00%
C-	58.00-61.99	1	3	3	7.00%
D+	54.00-57.99	1	3	5	9.00%
D	50.00-53.99	0	3	4	7.00%
F	0.00-49.99	0	6	3	9.00%
Total		20	34	46	

Delivering the RE e-Course online for 6 semester achieved promising results. The authors believe that continuing delivering the course for many other semesters with a larger sample size and constant continuous improvement through the semesters will yield better results. The study revealed that technical issues related to hardware infrastructure, network connection, and server availability still would negatively affect communication and interactivity despite the good levels achieved. Moreover, the questionnaire was not checked for validity, this issue was beyond the current study.

VI. CONLUSION AND FUTURE WORK

Improving education has been a prime priority for HEIs that seek to employ technology in learning to generate knowledgeable students. The success of e-Learning depends mainly on the quality of the course. Hence, in this paper, a proactive risk management framework that aims at ensuring high-quality e-Learning has been introduced. The framework was implemented in an online RE e-Course. In order to validate the effectiveness of the framework in developing the course, both users' satisfaction studies and students' grades analysis were conducted. This framework embeds an iterative approach to the development of instructional design products. Also, the framework is adaptable; it can be tailored to suit any e-Learning project according to its objectives, characteristics, audience and probable risks. Hence, the model proposed in this paper will serve as a tool for HEIs to define their customized models based on courses contexts and risks. The development of the RE e-Course was guided by the proposed framework. Its learning objectives and activities were designed and implemented according to good design principles and best practices in the literature with an eye towards avoiding e-Learning risk factors. Throughout the RE course case study, this paper pointed out 43 e-Learning risk factors that need to be addressed and 148 risk management strategies needed to address these factors. Hence, the paper also sets the foundations to overcome these factors and to improve the e-Learning approach in HE.

Satisfaction surveys analysis used Qualitative data and quantitative measurements; including mean, mode and standard deviation. These surveys were used to assess how each of these risks was mitigated. These surveys revealed that each of these

risks has been mitigated to a certain degree. Moreover, students' grades analyses were conducted to assess the quality of the learning. The study revealed that participants who concluded the course were highly satisfied and achieved good results compared with traditional course. This implies the effectiveness of the proposed framework in developing and delivering high-quality e-Learning courses. The approach in this framework is not the only way to develop an effective e-Learning content. Rather, it is a reasonable approach to ensure e-Learning project success and high-quality e-Courses based on the results we obtained. One dimension of the future work is to implement other online courses with a larger audience based on the framework to ensure generalizability of the framework. An issue is concerned with the validity of satisfaction surveys is left for future studies. Regarding items with less satisfaction values, further improvements are required to properly address the related risks. Furthermore, the correlation between students' satisfaction and the knowledge gain could be examined in the future.

ACKNOWLEDGMENT

This work has been accomplished through activities of two TEMPUS projects, the first entitled: "Modernizing Undergraduate Renewable Energy Education: EU Experience for Jordan - MUREE", project number 530332, and the second entitled: "Enhancing Quality of Technology-Enhanced Learning at Jordanian Universities", EQTeL, project number 544491. The authors acknowledge with gratitude and appreciation the generosity of the European Commission for its efforts to modernize and reform higher education in Jordan. The authors would like also to thank the Deanship of Scientific Research and Center of Academic Development and International Outreach at the Hashemite University for their efforts in facilitating working in above mentioned projects.

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