Cloud-Based Education As a Service (CEAAS) System Requirements Specification Model of Higher Education Institutions in Industrial Revolution 4.0

Yousef A. M. Qasem, Rusli Abdullah, Rodziah Atan, Yusmadi Yah Jusoh

Abstract*: *In today's higher education institutions (HEIs), intelligentization and digitization of education process are greatly required. Production industries are presently making changes from large-scale production to specialized or customized production. The term Industry 4.0 (IR 4.0) represents the fourth industrial revolution; the present movement or inclination of automation and data exchange and sharing in manufacturing technologies with the main aim of satisfying the individual customer desire and needs. The quick progressions in production technologies and its uses in the industries enhance production efficiency and change the workplace from tasks-based to the human-focused features. Higher education in the IR 4.0 (HE 4.0) is a complex, intricate and intriguing opportunity which has the potential to change the society for the better. The convergence and integration of man and machine will decrease the subject distance between social science and humanity and also technology and science. This will definitely need in-depth and diverse interdisciplinary teaching, research and innovation. Cloud computing (CC) as an IR 4.0 contributing technology, provides a novel means of educating people that will ultimately disrupt the present HEIs systems. Cloud-based education as a service in the era of fourth industry (CEaaS 4.0) can deliver education services in the shortest, most effective, and best affordability. The aim of this study is to propose a CEaaS system requirements specification (SRS) model that includes functional and non-fictional requirements; aligned with IR 4.0, the next industrial revolution.

Index Terms*: *Industry 4.0; Cloud Education; Higher Education Institutions HEIs; System Requirements Specification SRS.

I. INTRODUCTION

Subsequently after the first Industrial Revolution, the following revolutions have led to producing powered machine and production which are electrical and digital automated from water and stream and this has been known to complicate manufacturing and in the same vein make them automatic and sustainable in order to enable people to operate the machines in a simple, efficient and persistent manner [1]. "The word
Industry 4.0 represents the fourth industrial revolution which can be defined as a novel level of power and organization in the whole value chain of the life cycle of the product. It is

targeted at enhancing specialized or individualized needs of various customer [2]. The main aim of IR 4.0 is satisfying each customer's desire via the integration of physical items like enterprise assets, devices, and sensors both to the Internet and also to each other [3] [4].

IR 4.0 is still farsighted but a practical concept which comprises analytics, big data, Internet of Things, Industrial Internet, and CC [5]. A recent IR 4.0 PWC report [7] has stated that by 2020, European industrial companies will invest € 140 billion annually in IR 4.0 applications and more than 80 % of companies will have digitized their value chain. HEIs in the fourth industrial revolution, (HE 4.0) is a dialectical, intricate and intriguing opportunity which has the potential to change the society for the better. IR 4.0 is driven by the use of artificial intelligence it can change the work area from tasks centered appearance to features that are human-based [6]. Presently, all graduates are faced with a world driven by technological advancements, whereby CC, the Internet, and various social media like Facebook, twitter etc. create myriads of prospects and obstacles for the system of education that is formal. As graduates reflect on their life after graduating from the university, students face questions of uncertainty as regards their destiny especially as regards getting a job. With the IR 4.0 having CC as the major technology in relation to IR 4.0, a novel type of an institution is rising that carries out research, teaching, and service in another way. This university is known to cut across various disciplines, to have virtual laboratories, classrooms, virtual teachers, and libraries. However, this does not demean educational experience but enhance it [6]. In the perspective of HEIs, the huge production of mobile devices that are affordable, Internet broadband connectivity and loaded education content begin a pattern of changing the way education is made available. amongst other techniques, CC provides a novel way of bringing education to people that

Revised Manuscript Received on August 19, 2019.

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might ultimately change or disrupts the present HEIs systems [6]. CC can provide cloud-based education as a service (CEaaS) in the shortest time frame and in the most competent and reasonable form to improve 21st century students' skills and make students ready for the new labor force market in the utmost desired approach; also, to enhance and improve indigenous invention with the highest motivations; and distribute resources across districts, regions, institutions or the nation as a whole in the easiest means. The main focus of CEaaS is based on the acceptance that students' necessities and desire must be effectively met [6].

This paper, therefore, introduces a cloud-based education as a service (CEaaS) system requirements specification (SRS) model for HEIs that includes functional and non-fictional requirements; aligned with IR 4.0, the next industrial revolution.

II. Theoretical Background

Industry 4.0.

IR 4.0 has in recent times become a well-discussed and known terminology among researchers and industries alike. The initiative of the fourth industrial revolution powered by smart technologies was proposed mostly by Germany and its greatly developed industry made the perception achieves a comparatively undoubted acceptance [1, 7, 8]. Although there is still no consensual and agreed global definition that may characterize the idea of Industry 4.0 and its different components and this, include issues of efficiency of resource use and new paradigms for industries, businesses, product development and customer management [7, 8].

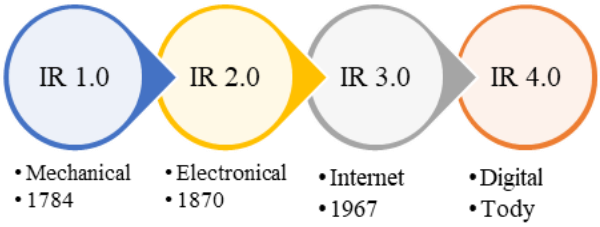

Fig. 1: The stages of the industrial revolution

In order to comprehend the revolutions of industries, Fig. 1 presents the steps of the industrial revolution. Newton fueled the first industrial revolution when he created the laws of motion. Since after then the concept of motion was understood better and measured, it is possible to construct stem engines that mechanize the work that was conventionally carried out by the human being. Faraday and Maxwell fueled the second industrial revolution, they brought together electric and magnetic forces, and this brought about electricity generation which is vital in the assembly plants that have taken over the industries. The invention of transistor fueled the third industrial revolution, this brought in the electronic age and we begin to have the internet and computers. The fourth industrial revolution was fueled by the German government in 2011, at the Hannover Fair and this word is presented under the heading of intelligent production. The fourth industrial revolution will modernize industries so greatly that the majority of the work that is present today will not be present in 50 years [6]. The industry 4.0 aims to target the digitization in an endwise manner of all physical resources and including it into digital ecosystems with important chain partners. The essential characteristics of the industry 4.0; devices, sensors, machines, and people, particularly through Internet of Things (IoT) to be incapability to communicate and constant communication with each other [7]. The desire of industry 4.0 is to change the conventional machines to a machine that will be self-learning and self-aware machines in order to enhance their effectiveness as a whole and maintenance management with the immediate interface [8].

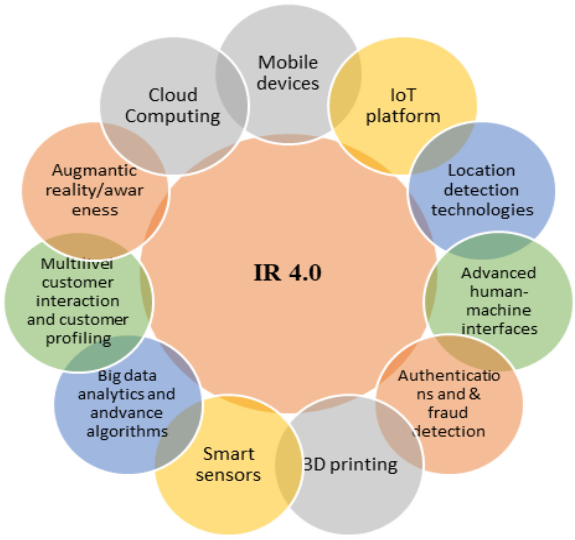

Fig. 2. Industry 4.0 Framework

While the term IR 4.0 is becoming more and more familiar, PWC (2016) suggests an IR 4.0 framework and contributing digital technologies that are powered by digitization and bringing together the value chain which can be vertical or horizontal, product digitization and service offerings, and digital business models and customer access. The viewpoint of industrial production targeted in the future is presented in Fig. 2, the contributing digital technologies fields including CC in relation to each other in the industrial production process. This circumstance is the root of IR 4.0 [9].

Cloud-based Education as a Service in the 4th IR Age (CEaaS 4.0).

The most important task of HEIs is still the same irrespective of the era. The aim of HEIs is to guarantee the quality of learning through teaching, to allow the students to have access to the latest knowledge via exploratory research, and to sustain the development of societies by means of service. The enhancement of HEIs system has passed through the following stages, which are, elite, mass, and post-massification [6]. The 21st century places itself as a taxing time requiring a specialized set of skills that are commonly overlooked in

conventional educational settings [10]. Since the advent of the century, researchers have made clear that the full presence of technology, in general, provided great changes in society especially in the sense of student engagement in the process of learning [11]. When considered

in this context, bringing in IR 4.0 to HEIs will enhance the quality of education. Because the internet and sensor technology provide an opportunity that allows users to establish an interactive system and also students in the field of education will have the opportunity to practice too. Additionally, the individuals have taken up the idea can build systems making use of this idea for developing own projects [12]. Given the 4th IR with CC as the main biller, cloud-based education as a service (CEaaS) can provide a number of educational features to the learning and teaching community such as students, researchers, faculties at schools, colleges and universities so as to streamline the entire education process by making it more efficient and effective. Fig. 3 depicts the conceptual meaning of cloud-based education as a service in the fourth industry revolution (CEaaS 4.0) of higher education (HE 4.0).

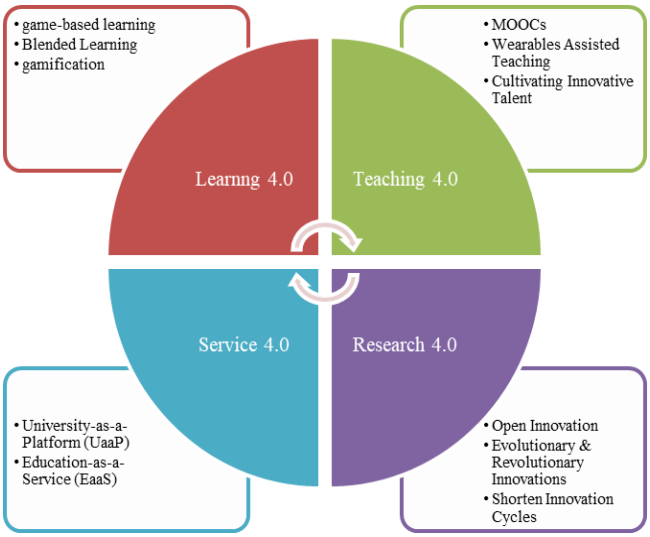

Fig. 3: Cloud-based Education as a Service Model in IR 4.0 (CEaaS 4.0)

Learning 4.0.

Learning 4.0 can provide a number of educational features to the learning community with different learning styles in various learning contexts in order to provide lifelong learning and information/knowledge sharing accumulated through CEaaS so as to streamline the entire education process by making it more efficient and effective.

Teaching 4.0.

One of the principal tasks of every institution is to educate the youth. Therefore, it is necessary to implement appropriate teaching strategies and to organize work in a way that fosters learning. This has implications on adaptable learning programmers, better learning experience, and lifelong learning attitude in the age of IR 4.0.

Research 4.0.

The journey towards global competition in the higher education requires institutions to put a huge amount of effort into research and development (R&D). Experts believe these forces range from new technology deployment to global cooperation and collaboration [6]. IR 4.0 could be a weapon to sharpen the way research and development (R&D) is HEIs.

Service 4.0. T

o sustain the competitive position among world HEIs system, we need to radically improve educational services [6]. In particular, we need to drive much greater innovation and competition into delivering cloud-based education as a service in the age of IR 4.0 to the educational committee.

III. MATH

To propose the Cloud-based Education as a Service (CEaaS) System Requirements Specification (SRS), an empirical analysis approach with a few phases [13, 14] has been followed as shown in Fig. 4.

Fig. 4: Phases in CEaaS System Requirements Specification

Phase 1: Analyzing the literature review.

This includes the process of IR 4.0 background reviewing, CC technology, HEIs in the age of IR 4.0, cloud-based education services, software/system requirements specification SRS, and the design principle of IR 4.0.

Phase 2: Formulation.

This phase consists of two sub-phases:

a) Formulating the CEaaS 4.0 model. This is the process of constructing and composition of the cloud-based education as a service in industry 4.0 based on the main fourth enablers (e.g. Learning 4.0, Teaching 4.0, Service 4.0, and Research 4.0) of the education systems in the age of IR 4.0 derived from the previous phase into a specific format or manner.

b) This stage deals with the identification of the functional and non-functional software/system requirements specification of a cloud-based education system based on Industry 4.0 based on the literature review.

Phase 3: Conversion.

Converting the result of previous phases into a cloud-based education as a service CEaaS system requirements specification (functional and nonfunctional requirements) aligned with Industry 4.0.

Phase 4: Evaluation.

This is the process of evaluation that involved another iteration of reviewing the literature in order not only to verify the proposed solution and but also a part as well as in enhancing of a standard

CEaaS system requirements specification.

IV. CLOUD-BASED SPECIFICATION REQUIREMENTS MODEL RESULTS

The fundamental criterion to quantify the success of a software system is the extent to which it pleases its customers. Customer satisfaction is measures or accessed by how closely and accurately the system meets different kinds of stakeholder needs. A software/system requirements specification (SRS) is an explanation of a proposed software system that meets this need. The system requirements specification (SRS) bring to mind two main requirements of a system; functional and non-functional requirements. A functional requirement of a system is an activity or task that a system must be able to perform [15], "what the product must do"[16], "what the system should do" [17]. Functional requirements can also be defined as the behavioral aspect of a system [18]; the kinds of requirement that specifies the inputs or the stimuli into the system, the response or the outputs from the system, and also importantly behavioral relationships between them; which is also referred to as functional or operational requirements [19]. The non-functional requirements of a system explain or describe the nonbehavioral aspects of a system, which includes the characteristics and limitation in which a system must operate [18]. The behavioral characteristics that the specified functions must have are also referred to as non-functional requirement and an example is a performance, usability [20]. There is a lack in the literature regarding the design principles that support practitioners in developing appropriate cloud-based solutions of IR 4.0. Therefore, to execute a CEaaS 4.0 in HEIs, a system requirements specification (SRS) is required to explain the functional and non-functional requirements that meet the education community needs in the age of fourth industry revolution 4.0. To perform the IR 4.0, different design principles should be considered. Based on a quantitative text analysis and a qualitative literature review, Hermann, Pentek [21] identified four design principles guiding practitioners and scientists on "how to do": interconnection, information transparency, decentralized decisions, and technical assistance. Baygin, Yetis [12] mentioned six principles of design which are, respectively that is orderly, interoperability, transparency of information that is simplicity and precision of information, technical support, real-time data purchase and processing, modularity and decision concerning distribution. Table 1 shows the analysis of these principles. Based on the analysis of the previous studies (Table 1) that describes the nonbehavioral aspects of a system (non-functional requirements) with the core functions of a cloud-based education system that delivers educations services in HE 4.0 (Fig. 5). A cloud-based education as a service (CEaaS) system requirements specification model is proposed (Fig. 6). The CEaaS SRS model should be considered in delivering education services in the fourth industry revolution IR 4.0.

Table 1 Industry 4.0 Design Principles

No.	Design Principle	Xing and Marwala [6]	Hermann, Pentek [21]	Baygin, Yetis [12]	Yang, Huang [22]
1	Interoperability / Interconnection		×	×	×
2	Transparency		×	×	×
3	Technical Support/assistance		×	×	
4	Decentralized/Distributed Decision	×	×	×	
5	Real-time capacity (Adaptability)			×	
6	Modularity			×	

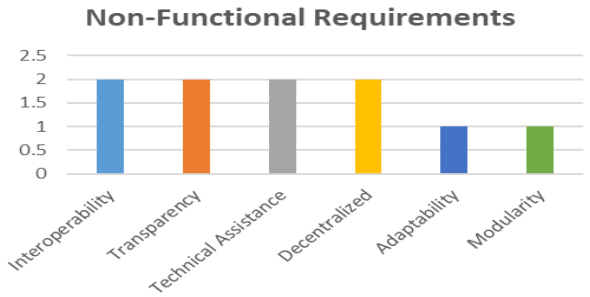

Fig. 5. No-Functional Requirements of CEaaS Model

V. CONCLUSION

Although the business of HEIs still stands unchanged since the times of Aristotle, students of this age still come together at a fixed time and place to listen and learn from the wisdom of scholars. With the fourth industrial revolution having CC as the major focus, a new type of a university is coming into the limelight that does teaching, research and service in another way. This university delivers Cloud-based Education as a Service CEaaS to smooth the progress of the needs of the major stakeholders in the cloud education community so as to enhance the effectiveness and efficiency of HEIs. The objective of this study was to recommend a cloud-based education as a service (CEaaS) system requirements specification (SRS) aligned with the next industrial revolution (IR 4.0) principles design. This study finds that interoperability, transparency, technical assistance, decentralized, adaptability, and modularity are the main attributes as no-functional requirements of the CEaaS model that may help in delivering cloud-based education as a service to the HEIs in the IR 4.0. It is also projected that the CEaaS SRS model will proffer insights in providing education services in HEIs in the era of the fourth industrial revolution. As a point of departure for further research, a sample of the model is needed to test delivering CEaaS to the educational community at HEIs.

Fig. 6. System Requirements Specification of (CEaaS 4.0)

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