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## THE CLOUD UNIVERSITY SYSTEM AT THE MONGOLIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Higher education was always known as the mean of society development support. Through the partnerships between universities, government and industry, researchers and students have put their contribution to the transformation of society and the entire world economy. The aim of our work was to identify the particularities of using Cloud Computing within higher education for colleges and universities. Mainly, we have considered the risks and benefits of cloud architecture and proposed a cloud adoption strategy proper for universities. An analysis of the data and the main activities that exist within a university was the starting point for choosing a cloud model that should take into account the special security requirements of higher education and the available cloud solutions as well. This research paper is including a study regarding the level of acceptance and the implementation effects of Cloud Computing at the Mongolian University of Science and Technology, as well as for higher education system of Mongolia /MUST/. MUST is the first university in Mongolia that committed to establishment and maintenance of the foundation of future Open University by maintaining of UNIMIS, a University's Management Information System.

**Keywords:** cloud computing, cloud university system, management information system, quality management system.

### Introduction

Cloud computing as an exciting development is a significant alternative today's educational perspective. Students and administrative personnel have the opportunity to quickly and economically access various application platforms and resources through the web pages on-demand. This automatically reduces the cost of organizational expenses and offers more powerful functional capabilities. There will be an online survey to collect the required data for the use of cloud computing in the universities and other governmental or private institutions in the region. This will help us review the current status and probable considerations to adopt the cloud technology. The gradually removal of software license costs, hardware costs and maintenance costs respectively provides great flexibility to the university management. In this paper we discuss a cloud computing based Management Information System. Cloud based Management Information System will help the students, staff, trainers, Institutions and also the learners to a very high extent and mainly students from rural parts of the world will get an opportunity to

get the knowledge shared by the professor on other part of the world. Even governments can take initiatives to implement this system in schools and colleges in future and we believe that this will happen soon.

In general, a higher education system in any country faces budget restrictions and sustainability challenges, one approach to relieve these pressures is cloud computing. With cloud computing, the operation of services moves — above the campus, and an institution saves the upfront costs of building technology systems and instead pays only for the services that are used. As capacity needs rise and fall, and as new applications and services become available, institutions can meet the needs of their constituents quickly and cost-effectively. In some cases, a large university might become a provider of cloud services. More often, individual campuses will obtain services from the cloud. The trend toward greater use of mobile devices also supports cloud computing because it provides access to applications, storage, and other resources to users from nearly any device. While cost savings and flexibility are benefits to the use of cloud computing, the downside of such service adoption could include possible risks to privacy and security. One important option is the development of collaborative service offerings among colleges and universities. Yet, substantial challenges raise at least some near-term concerns including risk, security, and governance issues; uncertainty about return on investment and service provider certification; and questions regarding which business and academic activities are best suited for the cloud.

In the current economic/financial situation and being challenged by growing needs, universities are facing problems in providing necessary information technology (IT) support for educational, research and development activities. The research methodology consisted in a rigorous analysis of the latest research on Cloud Computing as an alternative to IT provision, management and security. It also took into account the best practices for Cloud Computing usage within universities, plus the authors' experience in IT and higher education. Present economic situation will force more and more organizations at least to consider adopting a cloud solution. Universities have begun to adhere to this initiative and there are proofs that indicate significant decreasing of expenses due to the implementation of cloud solutions. This research work examines and discusses the concept of Cloud Computing from the perspectives of diverse technologists, cloud standards, services available today, the status of cloud particularly in higher education for Management information system, Learning management system, Quality management system and future implications

#### **The Mongolian university of Science and Technology /MUST/**

Founded in 1969, the Mongolian University of science and technology has been very successful as a university specializing in science and technology, producing a great number of leading engineers and professionals. With its cohesive organisation and superior quality of services to the society, our university has been recognized as one of the leading universities in Mongolia. The University is dedicated to continuing to build on our solid records of achievements of moving the institution from being one that has earned national recognition to one that is achieving to be education and research centre of excellence in the North-East Asia.

MUST was an initiator in restructuring measures and reforms among Mongolian higher education institutions. A number of universities and colleges of our country have followed these reforms and renovation practices started at MUST. Thus, it is noteworthy

to reveal here that encouraged with this fact, the community of MUST has been inspired with enthusiasms and vigour in pursuing new ideas and implementing it in real conditions.

### **Credit-Based System**

In terms of easy mobility of students in the era of globalisation, Credit-based system has been widely introduced. It is essential to note here that MUST community has made a substantial efforts for introducing Credit-based system in its activities in scale. With purpose to assist students in self-planning of learning process in Credit-based system e.g. selection of subjects, of terms to study a particular subject, of lecturers, an individual scheduling of time-sheet from general time-schedule of MUST.

### *Chair System*

MUST is the first university in Mongolia that devoted to setting up of chair system in which faculties are headed by leading and well-known professors by their research and academic work not only within the university but outside of Mongolia.

### *University's Management Information System "UNIMIS"*

MUST is the first university in Mongolia that committed to establishment and maintenance of the foundation of future e-University by maintaining of UNIMIS, a University's Management Information System.

### *Accreditation*

MUST is one of the first accredited universities in Mongolia. In addition, the first programme accreditation in Mongolia has been held in November 2003 and National Accreditation Council of Mongolia in the field of Engineering Technology has recognised a training programme on Telecommunications offered at MUST as an accredited programme that responds to all requirements of the international standards.

### *Joint and transnational programs*

*MUST is successfully developed the policy for recognition of international practices* as teaching of profound theoretical knowledge in higher education system of Russia, democratisations of training processes in American higher education system, leading roles of professors in Germanese and Japanese universities and has combined these experiences with accordance to substantial conditions in Mongolia. This policy is effectively introduced within the university and implementation is carried out by planned schedule. The university recognizes that the extension of foreign cooperation and the establishment of contacts with foreign institutions are a key approach for improving its training and research standards. Currently, MUST has academic links and around 30 Joint and Transnational programs with universities, colleges and institutions of over 10 countries of the world.

### **Institutional restructuring in Higher education: MUST, Asia**

In the modern period of fast-paced development of natural and engineering sciences, information reforms and in all spheres of sciences and creation of new fields as information technology, biotechnology and other modern technologies, there are demands in training of high qualified human resources, and engineering and technical driving forces with excellent skills in economy and management. With transition of national economies in competitiveness from industrial arena to the fields of large intellectual capabilities in higher education, science and technology, the competitive advantages and market position of countries have started to be measured by development degree of education, especially higher education and science levels. At present evolution period of

society in relation to knowledge century, the main grounds for national development of economies are considered to be measured by rate of higher education, thus, a quality of higher educated specialist is measured by degree of competences in meeting of social and industrial demands in modern societies. Therefore, in defining of development strategies, every country is emphasising the role of higher education in economy, social development, consolidation of nations, and sustainable development of the world. Not so long ago, availability of natural resources in a country played a significant responsibility in development of a country, however, at present-day a level of human resource development, particularly knowledge, creative thinking, capacity and skills of human resource are positioned at the priority level in any countries. Beyond matters of the geographical location, political situation and economic development, countries of the world determine the living standards of the countries with respect to level of education, especially level of higher education; and consequently education becomes a guarantee of economic wealthiness and national security of any country. In this era of significant changes it is a great pleasure to share with dear readers the following lessons learned in contribution to reform of Mongolian higher education sector by community of MUST and experiences in carrying out of restructuring measures<sup>1</sup>.

#### **A Cloud university system**

Higher education was acknowledged in time as one of the pillars of society development. Through the partnerships between universities, government and industry, researchers and students have proven their contribution to the transformation of society and the entire world economy. In higher education, the primary purpose of technology should be to enable and inspire innovation in the classroom and lab. That means giving educators, administrators, and students both the applications and the freedom they need to do their work. With the agility of the cloud model, IT organizations can try out new applications with minimal commitment, pay for as much as they use, and adjust as necessary. The cloud can also offer new ways for institutions of higher education to explore up-to-the-minute research opportunities by sharing cloud computing resources with other universities.

Like businesses that are rapidly adopting cloud services, higher education institutions are seeking a better and more cost-effective way to implement IT services, without the burdensome cost of maintenance and upgrades. Like businesses, higher education institutions want to respond more rapidly to new opportunities, without taking months, or even years, to implement a business-critical software application. And like businesses, higher education institutions want to realize the full potential of their data to better inform strategic decisions about the future. In spite of these similarities, higher education institutions have a unique culture and mission that affects how decisions about cloud computing are made.

- Commitment to students. Above all, higher education serves students. And those students come to campus with their own devices and expectations about how and when they want to use them. IT departments must now provide greater interoperability between campus and student platforms 7/24 access to secure, reliable networks and the ability to create, deliver, and share content campuswide on any number of devices. Cloud

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<sup>1</sup> International Institute for Educational Planning. IIEP/UNESCO. Paris, 2009.

computing is now as much about meeting student needs as it is about running an efficient campus.

- Complex finance models. Higher education finance models are complex and precarious, comprised of various combinations of tuition, philanthropy, investments, public funding, and research dollars.

- Participatory decision-making model. When developing a cloud strategy, higher education can draw on certain general principles from the business community. But an effective and durable cloud strategy for your institution will require: creating a framework built around the needs of your unique stakeholders -from students to faculty, board members to alumni, engaging all stakeholders early in the process, and developing an institution-wide cloud strategy that addresses IT challenges specific to higher education and your campus.

Public cloud computing will deliver benefits beyond the major universities. Its advantages may be even more pronounced in small colleges that have not yet achieved high levels of computerization, or do not have and have trouble recruiting people with adequate IT skills, or those worried about their ability to secure and protect data. By contracting with a cloud service provider (perhaps another, larger university), that small college can adopt state-of-the-art applications and services, enabling the college to skip a whole generation of academic computing, thereby bypassing many of the costly and debilitating challenges discussed previously. Challenges of Cloud Computing Many challenges of cloud computing for higher education relate to its relative newness and the underdevelopment of the marketplace for cloud services. For higher education, decisions to adopt cloud computing will be influenced by more than technical and cost considerations. Information is the lifeblood of higher education, and decisions on how to manage that information can have far-reaching political, social, and economic considerations.

The Internet and cloud computing technology is a winning combination. These two technologies have allowed vendors to develop a product called "cloud drives"; which is an online storage medium that allow people to save their documents, videos, photos, and music over the Internet. The advantages of a cloud drive is that it provides the capability for people to access their information from any computer around the globe at any time during the day. This type of simple technology allows people to become more productive by improving their access to information.

The concept of cloud computing and the present situation of management information system are to be introduced. This is followed by an analysis of the impact of cloud computing on MIS from the MIS development, operation and maintenance, as well as data security aspects. The conclusion is that the MIS development mode comprised, development methodology oriented workflow, operation and maintenance is simple and service-oriented with on-demand billing, minimalized resource cost, and constrained data security. In our case we can guide enterprises to carry out MIS strategy planning and construction in the cloud, improving the efficiency of MIS development and the probability of success, so as to enhance the core competitiveness of enterprises.

Cloud University system is an Internet-Based University management information system. It was developed on the UNIMIS system, which has been used by the Mongolian University of Science and Technology for 13 years. The objective of Cloud University is to establish an advanced higher education MIS and to help post-secondary institutions to implement assessment tools for existing databases and data collections mechanisms.

Developing integrated systems to use as a reliable instrument for policy creation, monitoring and evaluation, standards setting, regulatory frameworks, co-ordination and maximization of resources is paramount.

In the following, we will learn how you can take the first steps toward a custom-built cloud-computing solution by:

- Creating a comprehensive cloud strategy
- Designing a cloud-based architectural model
- Making the transition to the cloud

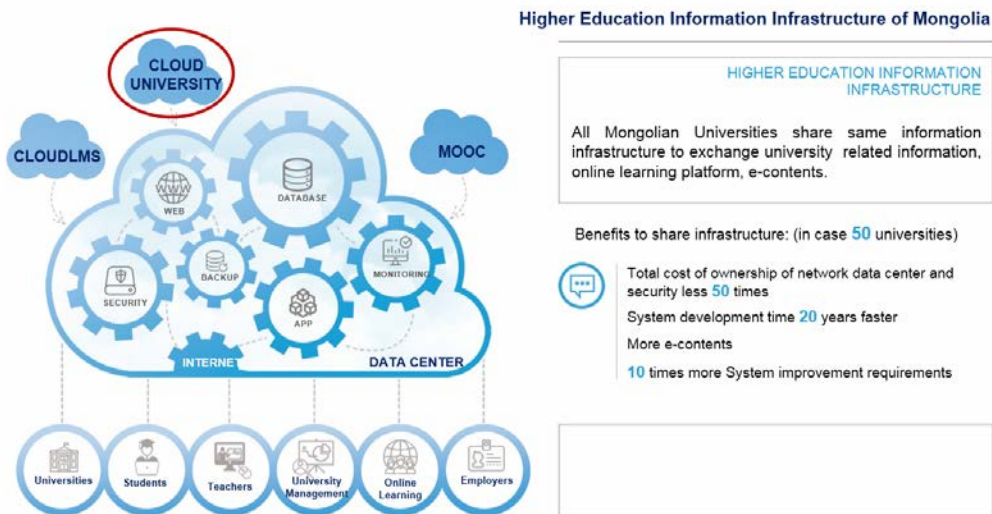


Figure 1. General Structure of Cloud University System

With a clearly defined wish list, organizations must then approach the cloud transition in the following four phases:

### 1. Strategic Preparation

In this initial phase, IT decision makers will determine the appropriate cloud computing strategy, asking questions about architecture and security, as well as about objectives. Colleges and universities should work with experts who have extensive experience in multiple technology areas, such as virtualization, service orchestration, automated provisioning, and the security that underpins network architectures. The costs, benefits, and operational changes required to successfully migrate to a cloud-computing model should also be evaluated, including both the current and desired services management approach. A thorough analysis helps align business results with subsequent cloud architectural development, tools, process integration, and implementation. Strategic preparation should also target security. University IT experts should evaluate their cloud services and architecture security risks, focusing on protecting access and providing on-

demand security options within a services catalog for their users. In addition, your strategy should take into account your cloud-computing evolution and post-deployment activities in every stage: strategy, planning and design, implementation, and optimization.

### *2. Planning and Design*

When undertaking a transition to cloud computing, strategic planning and design can help reduce the time to successful deployment and operation of complex cloud models. This phase requires expert coordination among the members of your team, your partners, and other vendors, as well as a detailed architecture design, data-center-specific expertise, and security designed from end to end. The resulting designs and plans — including, for example, an end-to-end architecture blueprint, a migration roadmap, a common control framework, a security technology framework, physical safety and security, and your future cloud services evolution — should link back to your strategy and lay the foundation for subsequent implementation and integration.

### *3. Implementation*

In order to reduce risk during a transition to cloud computing, college and university IT organizations need to have someone with experience in providing a virtualized architecture, as well as integrated tools, a facilities plan, orchestration integration, workload migration, and staging and validation activities prior to full-scale implementation. This phase also involves implementing the security technology architecture, the security portal design, automated audit, and physical safety and security designs. Proven methodologies, best practices, and deep knowledge of the core systems within the cloud environment can facilitate a smooth migration from your existing environment to a cloud utility computing architecture, while helping ensure adherence to plans and enabling on-time delivery of a fully implemented cloud-computing model. During this implementation stage, knowledge transfer should be an ongoing process, providing operational confidence for in-house experts.

### *4. Optimization*

Optimization of the cloud model, which can accelerate adoption, is the point where you can maximize the true benefits of cloud computing: lower operating and capital expenses, increased business agility and responsiveness, and scalability. This is done through activities such as:

- Architectural reviews
- Security audits
- Cost-reduction exercises
- Process improvements
- Tool customization

The cloud computing as a natural evolution of the Internet. Any university in Mongolia can use this system immediately. The Cloud University system can manage (organize) all types of university related services and management. The benefits of the Cloud University System include: 1) affordability, since only monthly payments are needed, 2) there are no costs for ownership, as there is nothing to install; only an Internet connection is needed, 3) an IT specialist is not required to maintain the system.

The quality management system rests on an appropriate organizational structure as well as good management and decision-making. Its foundation consists of the strategic plan as well as the University's target programme together with the related target programmes and action plans of the units (faculties, departments, independent institutes).

The quality management system supports the University's strategic objectives and helps both the University and its units to achieve them. The operations management process, which involves setting objectives and monitoring their achievement, is at the core of quality management. The University has defined indicators and quantitative follow-up targets to monitor whether it is moving in the direction defined by its objectives.



**Figure 2.** The Sub-Systems and Web portals of Cloud University System at the MUST

It is important for higher education managers to gain a solid understanding of how cloud computing is evolving, and the trends in its adoption. In the near term, Cisco expects rapid growth in thirdparty — public clouds offering many different application, computing, and storage services. Although academic organizations may choose to use these services-especially, we suspect, for standard business applications such as email or document creation-we think it is more likely they will elect to create their own private clouds for core applications, either alone or in partnership with other institutions of higher learning. Although higher education organizations will weigh the costs and benefits of each approach, we anticipate that a major factor of these decisions will be their level of trust in both the cloud deployment model under consideration and the entity providing it. Next Steps You can take several important steps now in preparation for cloud-computing adoption, whether public or private:

- Identify all potential opportunities and benefits for switching from existing computing arrangements to cloud services.
- Ensure that in-house infrastructure complements cloud-based services. The shift to cloud services is not all-or-nothing, and some cloud services (for instance, infrastructure services) will support the ability of in-house IT to extend into some clouds for additional compute and storage capacity. Virtualization will be a critical piece of a compatible infrastructure.



- Develop a cost/benefit and risk-evaluation framework to support decisions about where, when, and how you can adopt cloud services. Develop a roadmap for optimizing the current IT environment for adoption of public and private cloud services. Identify which, if any, data cannot be held in public cloud-computing environments for legal or security reasons.

The Cloud University system offers a new type of global communication and is available to everyone in the university community: students, professors, academic affairs leaders, university administrators, parents, employees and alumni.

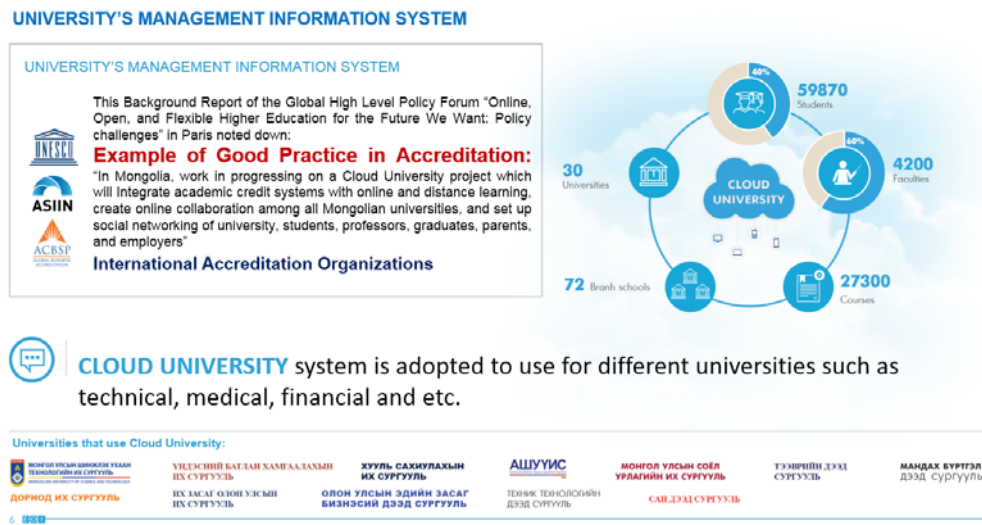


Figure 3. Users of Cloud University System

The MUST defines quality as expedient operations and high-quality results. The University's quality culture manifests itself in the high commitment of the staff and students to their work and studies. The staff and students collaborate in accordance with the values and objectives of the University and adhere to common policies. They also share good practices and engage in continuous evaluation. The University's quality system provides the necessary structures and defines the procedures and responsibilities for well-functioning quality management.

Quality work supports the MUST in achieving its vision defined at the Strategic plan. Every member of the academic community shall contribute to the common goal of achieving the University's objectives and shall be responsible for his or her performance and outcomes. The purpose of the University's quality system is to aid the academic community and its members in developing a framework for quality management. The University maintains and enhances the quality of activities through jointly determined procedures, processes or systems. The objectives set in the strategic plan, target programmes and action plans are the foundation for all operations.

Another purpose of the quality system is to assure that the quality management procedures set up to ensure the quality of operations are present in all operations. Quality

management system aims to continuously improve University operations and make development an inherent part of all activities and units as well as the work of individuals. It affects all members of the academic community: teachers, researchers and other staff as well as students.

#### **Example of Good Practice in Accreditation**

– In Mongolia, work in progressing on a Cloud University project which will integrate Academic Credit Systems with Online and distance learning, create Online collaboration among all Mongolia universities and set up social networking of university, students, professors, graduates, parents and employers.<sup>1</sup>

#### **Accreditation Criteria for Higher Education Institutions of Mongolia**

A national body for accreditation of education — the Mongolian National Council for Education Accreditation (MNCEA) — was founded in 1998 as an independent external agency by the government decision. MNCEA is quality assurance agency for the higher and technical –vocational education.

#### ***The mission of MNCEA:***

The mission of the MNCEA is to support the quality of academic provisions, to safeguard national standards for tertiary (higher and vocational-technical) education institutions and academic programs and to strengthen a visibility of Mongolian tertiary education at the international level.

The MNCEA will implement following objectives as below:

- To improve quality of education services on the basis of cyclical assessment of Mongolian tertiary education system;
- To recognize reputations of higher education institutions (HEI) and academic programs in a way of performing periodical accreditation;
- To adjust operationalization of national and international quality assurance agencies;
- To strengthen a visibility of Mongolian tertiary education at the international level.

The following criteria must be adhered to self-assessment process by a Higher education institution (HEI) as well as external assessment (auditing) process by the Accreditation board.

Self and external assessment would be evidence of sustainable development of teaching, research and service activities by HEI in accordance with social demands and requirements.

The main functions of criteria for HEI accreditation:

- To support the institution to achieve international recognition and competitiveness
- To ensure the major development principle is satisfied through HEI's operational managements, administration, quality and efficacy are improving continuously with evidence of staff quality improvement in responsibilities and work output.

In terms of formulating the HEIs criteria, all the respective directions which need to be continuously evaluated and developed must be titled based on their scope. There

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<sup>1</sup> The Background Report of the Global High Level Policy Forum — Online, Open and Flexible Higher Education for the Future We Want: Policy challenges in Paris, France, 9–11 June 2015.

are 5 criteria for input, 4 criteria for progress, and 1 criterion for output, and those 10 consist of 57 requirements in total.

**Criterion 2. Design and quality assurance**

The institution and its units must have long and short term operational and budget plan. The performance and output must be under periodic revision and assessment, and the efficacy must be enhanced.

*2.3. Quality management system*

The internal monitoring, analysis and assessment operations of institution must be approached to support autonomy of lecturers and students, performance with academic freedom and teaching quality assurance.

**Criterion 3. Governance and legal framework**

**The institution must provide with the condition of operational quality and efficacy through organizational structure, governance and legal framework that satisfy the demands by humane democratic society.**

*3.6. Information management system*

The institution must effectively operate information management system under constant upgrading based on modern information and communications technology.

**Criterion 10. The institution status at national and international level**

The institution must have its operation assessed at national, regional and international level and approach to enhance its recognition and status

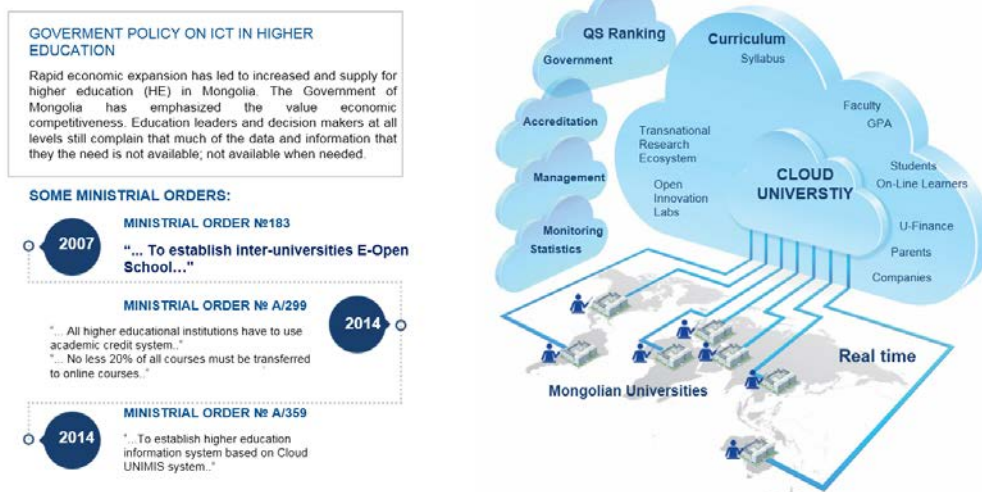
*10.5. International ranking*

The institution must be listed in international ranking and carry out a strategy to step up its rank.

*10.6. International recognition*

The institution must demonstrate its specific ranking through criteria such as membership and certification or credentials issued by regionally or internationally recognized quality body or society with authorization.

**Quality Management System /CLOUD UNiMIS/**



**Figure 4.** Quality Management System of Cloud University System

### **Conclusion**

Currently, cloud computing is considered the next best thing when it comes to optimize IT budgets in the current economic environment. It's believed that it will become a key technology oriented at sharing infrastructure, software or business processes.

Cloud Computing is a way to serve the needs of computation through the virtualization of some resources through the Internet. It's made of shared services under a virtualized management, accessible to users and other services through the Internet under a — pay per use payment system. The main reason is the acceptance and adoption of these revolutionary technologies. When speaking about Cloud Computing, risk management activities must take place throughout the life cycle of information, and risks should be reassessed periodically or in case of a change. Therefore, colleges and universities that have decided to use the services supplied within the Cloud must consider not only the implied savings and cost reductions but also the additional risks. Once risks are identified, a clearer picture will take shape at the level of management, of how cloud services will influence the structure and operations of teaching-learning processes. We can conclude that the future of the XXI century is run, when talking about innovative technologies, by Cloud Computing solutions which will, after going through some stages, fundamentally modify the general perception over the informatics domain.

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## ИНФОРМАЦИОННАЯ СИСТЕМА УПРАВЛЕНИЯ ВЫСШИМИ УЧЕБНЫМИ ЗАВЕДЕНИЯМИ НА ОСНОВЕ CLOUD COMPUTING TECHNOLOGY

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Высшее образование было признано во времени как одна из опор развития общества. Благодаря партнерству между университетами, правительством и промышленностью, исследователи и студенты доказали свой вклад в преобразование общества и всей мировой экономики.

Целью нашей работы было выявление особенностей использования облачных вычислений в высших учебных заведениях для колледжей и университетов. Главным образом, мы рассмотрели риски и преимущества облачной архитектуры и предложили подходящую для университетов стратегию внедрения облака. Анализ данных и основных видов деятельности, существующих в университете, послужил отправной точкой для выбора облачной модели, которая должна учитывать особые требования безопасности высшего образования и доступные облачные решения. Этот научный документ включает в себя исследование, касающееся уровня принятия и эффектов внедрения облачных вычислений в Монгольском университете науки и технологии, а также для системы высшего образования Монголии / MUST /. MUST является первым университетом в Монголии, который взял на себя обязательство создать и поддерживать фундамент будущего Открытого университета путем поддержки UNIMIS, системы управления информацией университета.

*Ключевые слова:* облачные вычисления, облачная университетская система, информационная система управления, система управления качеством.