Cloud Computing and Big Data in Learning Management System

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Abstract

Higher educations have to shift from conventional based learning-centred to a mobile based learning-centred institution that emphasises continuity of teaching anywhere and anytime. The recent adoption of cloud computing, Web 2.0 (web as a platform), and big data technologies have become the main driver of the paradigm shift. For higher education, choosing the right platform for a Learning Management System (LMS) is becoming more important than choosing a tool in the new paradigm. This paper discusses factors for an educational institution in determining a future direction for cloud based LMS to take advantage of pervasive knowledge management, efficiency and effectiveness of operations. Literature studies have extensively

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deployed for this study to portray the state of cloud based LMS initiative. The paper also presents the finding of mobile learning which is based on cloud computing in teaching that students use smartphone as learning aid due to convenience, portability, comprehensive learning experiences, multi sources and multitasks, and environmentally friendly. We found that the trends of cloud computing and big data will be predominant factor in viewing LMS adoption and implementation.

Keywords: Cloud Computing, Higher Education, Learning Management System (LMS), Big Data

การประมวลผลแบบกลุ่มเมฆและ
ข้อมูลขนาดใหญ่ในระบบการจัดการเรียนรู้

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บทคัดย่อ

การศึกษาระดับอุดมศึกษาต้องเปลี่ยนจากสถาบันที่มุ่งเน้นการเรียนแบบดั้งเดิมมาเป็นสถาบัน
ที่มุ่งเน้นการเรียนการสอนผ่านสื่ออิเล็กทรอนิกส์ โดยให้ความสำคัญต่อความต่อเนื่องของการสอนไม่ว่า
ที่ใดเวลาใด และเมื่อไม่นานมานี้ การใช้เทคโนโลยีการประมวลผลแบบกลุ่มเมฆ (cloud computing),
Web 2.0 (web ในฐานะเป็นแพลทฟอร์ม) และข้อมูลขนาดใหญ่ (big data) นั้น ได้กลายมาเป็นตัวขับ
เคลื่อนหลักของการปรับเปลี่ยนกระบวนทัศน์สำหรับการศึกษาระดับอุดมศึกษา การเลือกแพลทฟอร์ม
สำหรับระบบการจัดการเรียนรู้ (Learning Management System) ที่ถูกต้องนั้น ได้กลายมาเป็นปัจจัย
ที่มีความสำคัญมากกว่าการเลือกเครื่องมือในการปรับเปลี่ยนกระบวนทัศน์ใหม่ โดยการศึกษานี้ได้
พิจารณาปัจจัยเพื่อการกำหนดทิศทางในอนาคตของสถาบันการศึกษา สำหรับระบบการจัดการเรียนรู้
(LMS) โดยใช้ระบบ cloud เพื่อให้ได้รับประโยชน์จากการบริหารจัดการความรู้ที่แพร่หลาย และ

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การดำเนินงานที่มีประสิทธิภาพและมีประสิทธิผลในการปฏิบัติงาน การทบทวนวรรณกรรมต่าง ๆ อย่างแพร่หลายก็เพื่อที่จะแสดงให้เห็นถึงสถานะของการริเริ่มการจัดการเรียนรู้แบบระบบ cloud อีกทั้งยังได้แสดงให้เห็นว่าการเรียนการสอนผ่านสื่ออิเล็กทรอนิกส์กับการใช้พื้นฐานของระบบการประมวลผลแบบกลุ่มเมฆ (Cloud Computing) ในการสอน โดยนักเรียนนักศึกษาใช้สมาร์ทโฟนเพื่อช่วยให้การเรียนสะดวกสบายมากยิ่งขึ้น ทำให้มีประสบการณ์การเรียนรู้ที่เบ็ดเสร็จ หลากหลายที่มาและทำได้หลาย ๆ อย่างในเวลาเดียวกัน และยังเป็นมิตรต่อสิ่งแวดล้อมอีกด้วย เรายังพบว่าแนวโน้มที่ระบบการประมวลผลแบบกลุ่มเมฆ (Cloud Computing) และข้อมูลขนาดใหญ่ (Big Data) นั้น จะเป็นปัจจัยสำคัญในดำเนินงานของระบบการจัดการการเรียนรู้ (LMS)

คำสำคัญ: การประมวลผลแบบกลุ่มเมฆ การศึกษาระดับอุดมศึกษา ระบบการจัดการการเรียนรู้
        ข้อมูลขนาดใหญ่

Introduction

Higher education's encounter significant challenges to maintain the quality of academic programs and make important changes in their quality of teaching, learning, as well as research (Caret, 2013; Anshari, Alas, & Guan, 2015a). An institution needs to adapt strategically and to create new possibilities for learning through the benefits of Information & Communication Technology (ICT) to widen students' choices in the academic process. Universities are taking advantage of the recent development in ICT, especially the social networks, Web 2.0, mobile technology, and embracing Learning Management System (LMS) as an integral part of online learning architecture, meaning that LMS extends the recent online learning into more functionalities and features like multi-ways users' interactions. LMS is a widely used terminology to address online learning in a broader perspective because it covers information systems which include technology, students, and business processes. Recently, LMS has become a critical system for higher institutions in embedding ICT into the learning process. LMS is seen as a promising method for working adults who want to upgrade their education level.

As a system, LMS can be viewed as a strategy to retain existing users and attract new ones. User retention is important for growth and sustainability of the higher education as a service. LMS can also be used to extend other services to the users or customers. In the higher education environment, organizations are challenged not only to retain existing services but also to acquire pervasive knowledge within the LMS. With the growing competition among education providers, managing and providing better services through better LMS is a strategy that needs to be carefully planned to avoid failure. The reasons for failure may varies from users are not being ready for online learning systems, inadequate IT support, a poor interface, presentation and content, many hidden costs from the vendor, a complicated system, lack of support, etc. Future LMS initiatives must be seen as a strategy for significant improvement in services by solidifying satisfaction, loyalty and advocacy through ICT, and most importantly as pervasive knowledge gateway for the students. Consequently, LMS must address the dynamic nature of users' needs and adjustment strategies embedded in LMS.

The objective of this paper is to lay the foundation in higher education to consider emerging technologies to enhance LMS as a service. This paper is organised as follows: the next section will discuss in more detail the literature analysis on LMS and cloud computing, Section 3 explains research methodology, the discussion is in Section 4, and Section 5 is the conclusion.

Literature Review

Learning Management System (LMS)

How ICT is transforming higher education? Universities show utilizing an advance ICT to revolutionize the way to deliver the knowledge and contents. For instance, social networks provide opportunity for researchers or research groups in universities for collaboration and knowledge sharing. It helps to find collaborators for research and possibility to communicate with other researchers in the same research cluster.

The use of ICT as educational tools and resources is not a new model. Terms like computer-based instruction, computer assisted instruction and computer assisted learning were used to describe earlier applications of electronic instruction. In addition, online learning systems such as Course Management Systems (CMS) or Learning Management Systems (LMS) enhance instructors and students to share instructional materials, make class announcements, submit and return course assignments, and conduct conversations with each other online. LMS is an information system that facilitates e-learning and processes, stores and disseminates educational material and supports administration and communication associated with teaching and learning (McGill et al., 2009). The roles of LMS in managing online learning and improving services to a university have been well recorded in many studies. Higher institutions these days use LMS as a tool to serve stakeholders which include students, lecturers, management, community, etc.

In the last decades, the LMS has been one of the most significant developments of ICT in higher educations to support the teaching and learning process (Coates, James, & Baldwin, 2005). Adoption of LMS is growing worldwide. For instance in 2007 over 90% of US universities and colleges had established one or more LMS-type products for student and faculty use (Hawkins & Rudy, 2007). Early adopters of LMS were convinced that it made teaching more efficient (Morgan, 2003) and most early LMS

systems are used only for the distribution, management, and retrieval of course materials (Lonn & Teasley, 2009). A study at one university in USA that there is a strong relationship between a student's performance and time spent on LMS (Whitmer, 2012). The more the students spent on LMS, the higher their final grades. Nevertheless, there are always challenges for the students' behaviour in online learning such as feeling isolated, lack of effective advice, cost and motivation, feedback and teacher contact, student support and services, lack of experience, irrelevance of online studies, frustration in learning and training (Hara & Kling, 1999) which in turn led to higher dropout rates than among traditional students (Falowo, 2007).

LMS can provide dynamic interactive, alternative learning experiences to students where blended instruction (using face-to-face and distance oriented pedagogical methods) can have a large advantage relative to only face to face instruction or instruction conducted wholly online (Greenberg, 2009). There are challenges when an organization has decided to deploy LMS. For example, the issue of service disrupting student learning, learner computer anxiety, instructor attitude toward online learning, course flexibility, course quality, perceived usefulness, perceived ease of use, and diversity in assessment are the critical factors affecting learners' perceived satisfaction (Sun et al., 2008). However, emerging technologies are also significant to be considered for the next generation of LMS in higher education.

Cloud Computing

Higher education is a service oriented and aimed to optimize stakeholders' needs, efficiency and effectiveness for of all internal operations, and all interactions. Service orientation may be applied to individuals (including roles, capabilities and characteristics), universities (in terms of strategy, structure, culture and processes), and also to technology (according to the semantics, applications, architecture and infrastructure of modern institutions) (Mircea & Andreescu, 2010; 2011). The concept of cloud computing has emerged with new paradigms attributable to the arrival of Web 2.0 (Esri, 2013). Cloud computing enables a higher institution may not necessarily invest in ICT infrastructure to serve the need for LMS but find it more beneficial to consider renting the system and resources to keep a university focus in their core business (teaching and research).

Cloud computing eliminates the need to install and run the application on the users' own computers. In fact, it lessens the internal IT staffs' burden of maintenance, monitoring operations, and 24/7 support for any incident that may occur. There are three types of cloud computing; Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software-as-a-Service (SaaS) over the Internet (Rimal et al., 2009). IaaS is a cloud computing model in which an organization rents the infrastructure to support business operations such as hardware, storage, servers and networking components. The organization pays on a per-use basis and the service provider is responsible for managing, maintaining, storing, and housing the equipment. PaaS is a cloud computing model in which an organization rents the platform or development tools from the cloud service provider so that the organization can create their own system application. Finally, SaaS is a cloud computing model in which an organization rents the software and ready-to-use application to support business operations. The organization pays on a per-use basis and the service provider is responsible for all systems to make sure it runs without any problem.

Considering cloud computing LMS promises many benefits when current IT investments are directed to the maintenance of infrastructures such as servers and in house data storage devices (Armbrust et al., 2010). It can be significantly decreased by the use of cloud computing to save the data storage from their current budget. With cloud computing, higher institutions are able to avoid over-investing in ICT infrastructure and training staff. The organizations can take advantage of using a cloud when the ICT capacity needs extensibility, customizability and scalability (Vouk et al., 2008; Doelitzscher et al., 2011). From the users' perspective, students are familiar with and have used many of the cloud services in their daily life (Ercan, 2010), while the teaching staff benefit from support in preparing their teaching process, portfolios and evaluation (Thomas, 2009). Cloud computing provides the advantage of the ability of working and communicating in the educational environment without taking into account space and time (Vouk et al., 2008).

There are many benefits for cloud computing in higher education. Those benefits may range from providing educational resource storage and databases, e-mail, educational applications and tools for students and teachers and clients located all over the world involved in an educational program (Sultan, 2010; Cappos et al., 2009). However, the main advantage

is cost effectiveness for the implementation of the hardware and software and this technology can improve the quality of current systems of education at an affordable cost (Ghazizadeh, 2012). The most importantly, higher educations can focus on their core business of teaching and research while cloud computing manages complex IT configuration, maintenance, and software systems through quick deployment (McCREA, 2009; Tout et al., 2009). In general, reducing cost and increasing efficiency are primary motivations for moving towards cloud computing. Many universities deploy cloud computing due to a cost-effective solution to the problem of providing reliable services, data storage, and computing power to a growing number of students without investing more in physical machines and maintenance costs (Al-Zoube, 2009).

Social Networks

The emerging Web 2.0 technology such as social networks, blogs, wikis, and video sharing, the capability of current electronic learning (e-learning) technology can be enhanced further (Anshari et al., 2012). The idea of utilizing cloud computing in LMS is in parallel with the recent trend of workflow models characterized by the concept of Web 2.0. Introducing Web 2.0 in LMS can be expanded to incorporate the students' capability not only to receive but also to generate information. The advancement of Web 2.0 has energized students to have better control of information flows in LMS especially in generating contents in social network interactions (Almunawar, Anshari, & Susanto, 203). From the higher education perspective, the use of Web 2.0 can be utilized to sustain the process of learning (Baxter, Connolly, & Stansfield, 2011). Web 2.0 tools are important for developing of social network to support knowledge sharing. Social networking can contribute in strengthening or enhancing the relationship between students and tutors. These tools can serve as enablers in creating social network in learning (Anshari & Almunawar, 2013). Web 2.0 has enabled a mechanism to extend the service of LMS by accommodating students' empowerment such as enabling them to participate more actively in the process of through a social networking.

Big Data

Big data is defined as an extremely large data that are analyzed with technology to show the patterns of human development or anything related

to the society (Anshari & Alas, 2015a). Extremely large data that is beyond what a traditional processing tools could manage or analyse is said to be big data (Ohlhorst, 2013). Thus, any data that beat current processing technology is considered to be big (Gartner, 2012). The data is too big, moves too fast, or does not fit the strictures of your database architectures. It is important for higher education as big data leads to more precise analysis thus helps to bring more accurate decision making and more knowledge resources. Big data in a higher education can be collected whether through online or offline. These data can be gained from various sources such as social media (Facebook or Twitter posts, etc.) which can be used for the organization's use to understand the patterns made by the users (students, teachers, researchers, communities, etc.) or machines like smart meters e.g. recording how much energy consumption of electricity, water and even gas (Watson, 2014). This information amplifies the fact that data could be analysed and used to reveal patterns within the processed data. In other words, it could greatly help the higher education to understand the behaviour of students and use it to their advantage.

Big data is designed to extract knowledge from large volumes of a wide variety of data by enabling high-velocity capture, discovery and analysis (Villars et al., 2011; Anshari & Alas, 2015c). The purpose of volume in the data is that they are gathered by higher institution which is later used for further knowledge. Big data allows more storage space compared to traditional data that is only limited at a certain range and has storage issues. The data variety is a data from multiple data sources, data types, which include semi-structured and unstructured data. Variety is the type either of data that can be compromised which means that it can be structured or vice versa. Then, velocity refers to the data processing speed. It is fast in the case of very large amounts of data, but also be able to do real-time processing of data. Velocity deals with the time or speed in which the big data is being processed. Finally, to gain value and extract knowledge from this data, an organization users must choose an alternative way to process it (Dumbill, 2013) since big data is more and different kinds of data than is easily handled by traditional relational database management systems (Watson, 2014). Big data is data that exceeds the processing capacity of conventional database systems. These considerable big data analysis will continuously grow larger in line with the constant advancement of ICT. Big data is the big transformation that can affect our future LMS. This paper will introduce a possible big data adoption in LMS.

Methodology

With all the promises and benefits offered by cloud computing, Web 2.0 and big data, the research attempts to analyse the factors that a higher education considers those emerging technologies in LMS. The objective of the study is to investigate recent LMS adoption through cloud computing, Web 2.0 and big data. It is in-depth analysis of the researches on cloud computing, Web 2.0, and big data as an alternative to LMS in higher learning institutions. Contents analysis is applied for reviewing fourth literature reviews in peer reviewed journals. The review process then is clustered into main components of integrating cloud computing, big data, and Web 2.0 into LMS. In addition, the study employed focus group discussion on mobile learning experiences in using LMS. Focus group discussion involved a group of undergraduate students at Brunei who come from similar social and cultural backgrounds and they have similar experiences of cloud based LMS.

Discussion

From focus group discussion, the study reveals some important facts of mobile learning, as participants agreed with the conveniences of mobile learning in supporting their learning. *"mobile learning is easy to use, effective and fast, it is very convenient and efficient where we can do multiple task in just one device. Student can easily find information with the help of smartphone. We will not have to trouble ourselves with going through various books to find the sources you want. i.e e-library helps students to find the book we want and the location. Education contents goes with students whenever and wherever they go."* In previous times, if students left their homework or assignments (hard copy) at home then for sure they were scolded for not handing their work on time, *"but now if we forgot at home, as long as we have our soft copy, we can either print it out or send it via e-mail."*

Mobile learning is environmentally friendly because it reduce use of papers *"It saves a lot of paper therefore saves trees which is good for the environment we can read books in the dark because you have the light of the screen shinning into your face. In addition, it saves plenty of space because of the information and books are all can put in one device furthermore, diligent work of doing research as not many information in the Internet are accurate."*

However there are many features of entertainment programs that can disturb mobile learning that is procrastination such as watching videos or playing games. Some students are too attracted to smartphone that have become anti-social. The time they spend on the devices has become precious than the time we spent off-screen. Participants view that the other challenge is downgrading personal communication skills *"as they become convenient with the world of texting. We can also be too reliant on technologies, losing simple everyday life skills along the way."*

Mobile learning is very convenient and there are digital contents available instead of using textbooks materials. It can receive and generate multimedia information in a flexible and efficient manner. Student mentioned that having a smart mobile device during the lecture could actually make students write their notes faster. Some students experienced hand problem when they wrote many lecture notes, cloud based LMS make students do not need to write everything down from the slides/whiteboards. Students could browse through information on the spot. It is faster, convenient and timesaving. Many sources of learning materials in terms of text, video, audio, conversation, discussions, sharing notes and knowledge, taking picture of lecture, recording presentation, sharing video lecture, in one device.

How can higher institution like universities survive in a high competition landscape when they are dependent on static knowledge source due to fixed infrastructures? It is important for higher education to consider alternative to enhance role of LMS into pervasive knowledge management (Anshari & Alas, 2015a). Changes may take place in the institution because the demands of interested parties must be addressed to make them at the competitive state. When ICT is always changed and LMS as a service are being used for the daily operation. It is crucial to adapt an appropriate strategy to stay competitive. Higher education can respond to these changes by adopting a strategy of diversification in terms of service and facilities. Extending services and facilities can be supported through cloud computing, Web 2.0 and big data as shown in Figure 1.
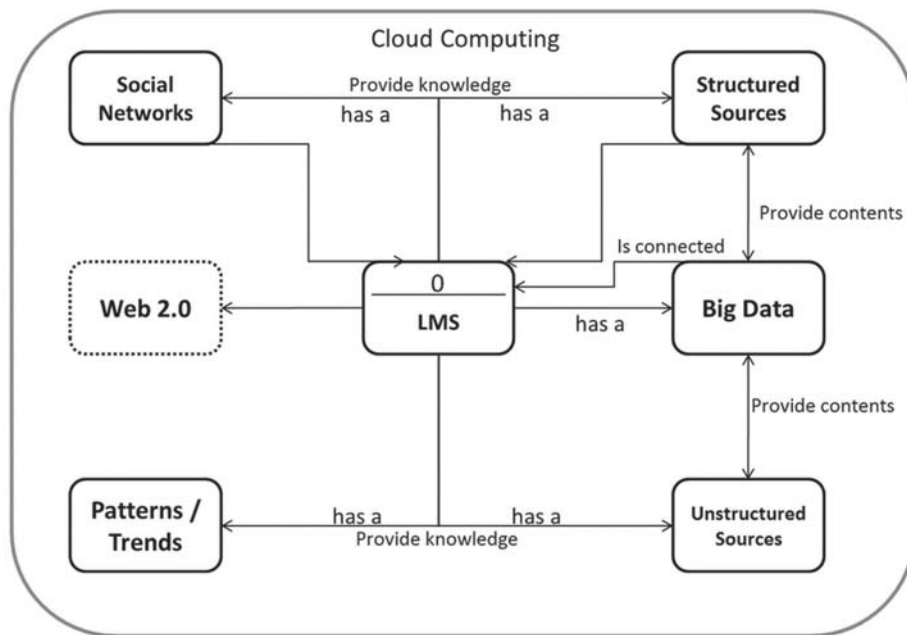
Figure 2: Web 2.0 and Big Data in LMS

Firstly, cloud computing can govern the operation and service of LMS. Cloud computing LMS is no longer a static platform for business implementation, but it offers robustness to create a multiple learning platform without a burdens for maintenance and system update. For instance, when the higher education requires technological and system update due to changing demands from the existing system, then cloud based LMS can be easily fine-tuned to the latest version. Diversification of business can offer a range of LMS services. The services include distance learning and blended learning (online and face-to-face). Each service has its own target group and niche market.

The organization can minimize the effects of dependencies by selecting more profitable and controllable domains/niches in doing business (Almunawar & Anshari, 2014). It means a university may reduce dependencies towards investing internal IT infrastructures (servers and storages) that require routine maintenance costs and servers' license. In addition, cloud computing based LMS can easily update version that is more acceptable with the recent trends and students' style. In addition, cloud computing LMS empowers an institution to develop a specialty or offer exceptional service to those uncomfortable with traditional learning processes faster than developing

LMS internally. For example, universities can secure business on full distance learning or online certification programs to serve the needs of the public officers and the private sector, which regularly need to improve their knowledge and skills but have no time to attend classes.

It can be concluded that the biggest advantage from cloud based LMS is that a university can move quickly in adopting the latest and reliable LMS technology to grab the market share by offering quality content of online learning to customers. As the adoption of the Internet by customers increases, there are more and more customers constantly depending on online services which the university needs to respond to.

Secondly, Web 2.0 in LMS is becoming important facilities for learning and teaching at higher education (Anshari et al., 2015). The initial aim of using the LMS was to have a medium to share notes with the students. The reason to include Web 2.0 in LMS was because the system has similar features with Facebook, where students are familiar with. Web 2.0 offers the vast features of the LMS, it is not only used the system for sharing notes, but also for giving assignment, grading their work, taking attendance and giving them online discussion. The students' comments and participation in generating knowledge were that they found it easier to use as it is similar to Facebook. One of the main reasons students like the Web 2.0 is that they can view the notes from anywhere and anytime they want.

Web 2.0 has enabled students to dynamically enrich their personal related information (Low & Anshari, 2013). LMS with features of Web 2.0 have empowered students with the ability to conduct conversations with other students to share and exchange experiences through discussions in their social networks. All the recent development should be incorporated when considering LMS initiative.

Thirdly, big data has an extremely disruptive impact on most organizations including in higher education as knowledge resources (Anshari, Alas, & Guan, 2015b). It is expected to change the way an organization plans and runs their businesses (Williamson, 2014). Big data is also creating a high demand for people who can analyse and use big data (Watson, 2014). Big data have an enormous potential to create a better future for LMS in its role as knowledge resources and tool.

One of the ways where big data helps to improve higher education is through observation (Anshari & Alas, 2014). For example, at the university, just by recording, examining or analysing every students Internet behaviour at university network, it helps to finalize the condition of the bandwidth need, students interest not only that it helps to reveal the conditions but most importantly knowledge acquisition and value creation. Knowledge acquisition and value creation are the focus on creating value from data generated students' conversation in social media.

Recommendations

There are at many factors that a higher education might consider to deploy LMS in order to allow the university to focus on teaching, learning, and research with less infrastructure support. First, scalability of service, as cloud computing offers scalability to the organization needs compared to an internal data centre which is not able to change the storage amount without purchasing, installing, and maintaining more equipment. Second, cloud service providers offer affordable cost compared to developing an internal data centre which requires high cost maintenance and administration annually. Third, security and privacy need proper arrangement because cloud based LMS is entrusting data to the external service provider which need to be protected. The institution must carefully engage with the vendor that can guarantee the issue of security and privacy. Fourth, to fully operate the big data require these four dimensions which are volume that is large, Variety from structure to unstructured of all varieties such as video, audio and text. Velocity is how fast the data is processed, and extracting Value requires applications and technologies for gathering, storing, analysing, and providing access to data. Therefore, large storage processing computers that consist of very high processing software and it is very complicated and expensive. Finally, there is no single solution fits for all scenarios, higher education should carefully decide at which direction that the institution is going to upgrade for LMS before understanding the needs of users towards the systems. This study triggers research directions that LMS can embed pervasive knowledge management from multiple sources like social networks through the support of cloud computing is key to competitive advantage. The concept of pervasive knowledge management in LMS opens a new opportunity to maximize the potential of generating knowledge into LMS. Pervasive knowledge is not only from social networks generated data.

Social networks can become data source that is voluntarily generated by students. Though, there are always challenges for the realisation of value added from pervasive knowledge in LMS, therefore next stage of study is important to configure its feasibilities for development.

Conclusion

Considering mobile learning through cloud based LMS offers benefits of rich contents deliverability, knowledge sharing, and dynamic learning activities where students can expect to experience multi channels interactions of learning. The emergence of cloud computing have improved capabilities of higher education processes which are more cost efficient, easily accessed, and reliable. Higher education often spend a huge budget on maintaining internal systems through their personal IT team while ICT is rapidly changing which affects the changing of users' behaviour. In this regards, LMS can be an alternative solution for universities to follow the technological trends and at the same time fulfilling the users' demands. Higher education can save on repair and maintenance, system and licensing, and physical space. In addition, organizations are increasingly driven to cloud computing which will increase functionality, lower costs, and enhance convenience to users by making the services and resources available anywhere anytime. In addition, big data can be characterized by four Vs; Volume (great volume), Variety (various modalities), Velocity (rapid generation), and Value (huge value but very low density). Accommodating big data in LMS is as important as the Internet to everyone, especially to higher education which produces high calibre research and development. More data helps to make more accurate analysis, produce more knowledge, and leading to a better decision making.

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