AN EVALUATION OF VIRTUAL LEARNING ENVIRONMENTS IN THREE OPEN UNIVERSITIES IN ASIA

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ABSTRACT

Open universities have provided quality higher education through open and distance education to serve learners who could not attend traditional in-person universities. While open universities vary in terms of providing their services to learners at a distance, many have shifted to e-learning using cost-effective platforms. A common platform that is essential for online teaching and learning is the learning management system (LMS). While there are common processes observed among open universities in the way they use their LMS, there are also subtle differences caused by each institution's unique and special context. Their contextual challenges often drive them to develop technologies or techniques that may easily be adopted by others. Thus, benchmarking activities are often recommended for mutual improvement. In this regard, a comparative study of open universities in Indonesia, the Philippines, and Pakistan was conducted for decision-makers to understand how they could improve in providing quality education to their learners through Moodle, which is their primary LMS. The Delone and Mclean Model was used to systematically compare system, information, and service quality in e-learning delivered through their LMS. The authors hope that the results and recommendations from this study may help other educational institutions overcome similar challenges in their learning platforms.

Keywords: Learning Management System, Moodle, Delone and McLean Model.

INTRODUCTION

One of the United Nations' sustainable development goals is quality education, which means "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all" (Hanemann, 2019). However, traditional higher education institutions, especially in Asia, are struggling to meet this goal. Their attempts to ensure inclusiveness and equity in education are often deemed insufficient due to various geopolitical and economic challenges. Therefore, open universities have become instrumental in widening people's access to education and promoting lifelong learning in Asia by providing more options

for disadvantaged learners. Furthermore, open universities are known to be implementers and promoters of open educational resources (OER) and free online courses. Many of these universities are members of the Asian Association of Open Universities (AAOU).

AAOU, founded in 1987 is a non-profit organization of universities that are primarily engaged in open and distance learning (ODL). This association aims to promote ODL and strive for quality education and access for all. It strives to allow people from all walks of life gain access to the vast wealth of knowledge that these institutions, together with their partners, possess.

Among various platforms for teaching and learning, the learning management system (LMS) stands out as one of the most essential technologies in ODL due to its affordances that are apt for addressing challenges related to the spatial distance between students and the educators. Since open universities have increasingly reported successful and innovative LMS implementations, the interest in utilizing them even among traditional universities as a virtual learning environment (VLE) for blended or fully online learning has been gradually increasing. In ODL contexts, students face more administrative and technical problems than students in traditional universities. Furthermore, as an open university's LMS largely facilitates online learning transactions, ensuring quality in its implementation and management is extremely crucial. Being a type of information system (IS), the success of implementing an LMS can be measured using an IS success model proposed by Delone and McLean (2003). Comparing the success indicators of ODL institutions (i.e., open universities) implementing the same LMS could help improve certain aspects of their operations and serve as an effective benchmarking activity.

REVIEW OF RELATED LITERATURE

The literature is plentiful, with papers describing and comparing LMS implementations across universities. However, most of them were comparisons between *Moodle* and other learning management systems like Blackboard, *LAMS* and *ATutor* (see Bower & Wittmann, 2011; Carvalho, Areal, & Silva, 2011; Lengyel, Herdon, & Szilagyi, 2006), and other platforms like Facebook (see Jeljeli, Alnaji, & Khazam, 2018). Even more abundant were evaluations of Moodle in a single university like the ones done in Sri Lanka (Marikar & Jayarathne, 2016), Jordan (Hasan, 2019), and the Netherlands (Conijin, Snijders, Kleingeld, & Matzat, 2016). The authors have not found any published study that systematically and comprehensively compared the success of LMS implementations of the same platform as Moodle among open distance Learning (ODL) institutions like open universities from different cultural and geographical contexts. The closest to this criterion was the work of Wang, Tseng, & Chang (2013). They compared student perceptions of Moodle between a university in Taiwan and Portugal. However, these were residential universities that used the LMS for blended learning. The gap in literature led the authors to ask five research questions:

1. What are the general and technical differences among ODL universities implementing the same LMS platform?
2. How different is user satisfaction among ODL universities implementing the same LMS platform?
3. How different are users' intentions to use and net benefits among ODL universities using the same LMS platform?
4. How different are the quality of LMS implementation among ODL universities using the same LMS platform?
5. How is the quality of LMS implementation related to users' intention to use and user satisfaction in these universities?

THEORETICAL FRAMEWORK

To analyze and compare the successful implementation of Moodle in three universities, a multidimensional model was chosen as the research framework. According to Wu & Wang (2006), DeLone and McLean IS success model is one of the multi-dimensional models used in many different fields. However, the concept of measuring the success of information systems is still not very mature. This model is based on six dimensions. This comparative study will primarily subscribe to the Delone and Mclean Information Systems Success

Model, which investigates the system quality, information quality, service quality, user satisfaction, intention to use, and net benefits. The model was recently proven valid and reliable (Sirsat & Sirsat, 2016).

Figure 1 shows the components of the Delone and McLean IS success model and their hypothesized directional relationships.
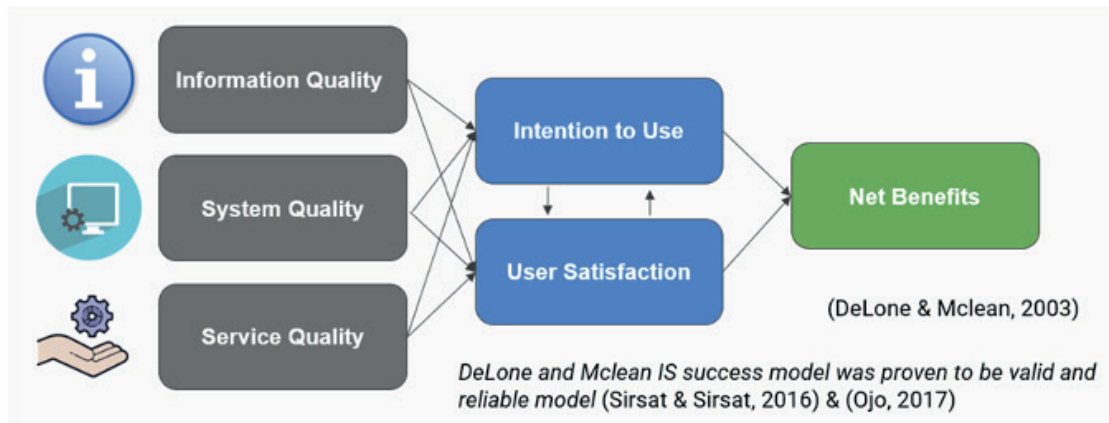

Figure 1. DeLone and McLean IS success model

System Quality

System Quality measure focuses on the usability of the system, and it also covers the performance characteristics of the system under investigation. System quality may cover access, convenience, customization, data accuracy, ease of learning, ease of use, response time, reliability, interactivity, system accuracy and system features, etc.

Information Quality

This measure of success is more related to output. The output required by the user and the output generated by the IS. The closer these two are, the higher the success rate and satisfaction of the user.

Service Quality

In this measure of success factor, technical support or help provided by the IT department is covered. This may include assurance, empathy, flexibility, interpersonal quality, and responsiveness of the support team.

User Satisfaction

It covers the level of satisfaction while using an IS. It is a very important measure of success. User satisfaction is not an isolated measure as it is interlinked with other measures like service quality.

Intention to Use

This measure indicates the frequency, usage, or intention of the user in utilizing the system. This also includes actual use, daily use, nature of use, number of transactions, etc.

Net Benefits

This measure is the summary of all previously mentioned measures. This is closely related to the benefits of all stakeholders involved (Urbach & Muller, 2012).

METHODOLOGY

The study was primarily conducted at the University of the Philippines Open University when two of the authors stayed in the Philippines as visiting researchers in 2019. The study followed the Delone and Mclean IS Success Model as a framework but added general and technical comparisons to investigate further factors that could have contributed to differences in relevant variables. This section starts with a restatement of the research questions into research objectives, followed by the recruitment of participants, a description of instruments, data collection methods, and analysis performed to answer each research question.

Research Objectives

This comparative study aimed to achieve the following objectives:

- To compare the general and technical aspects of Moodle implementations in AIOU, UPOU & UT.
- To compare user satisfaction from LMS implementations across the three universities.
- To compare users' intention to use and net benefits across the three universities.
- To compare the quality of LMS implementations across the three universities.
- To determine associations between quality dimensions, satisfaction, intention to use, and net benefits.

Participants

The authors interviewed ICT Directors of each university to collect data regarding general and technical aspects of their Moodle infrastructure. The survey was given to participants who were either faculty members or students of the three universities. There were a total of 15,566 respondents. Figure 2 shows bar plots that illustrate the distribution of participants in various categories. UT had the most respondents (n = 14,526), followed by AIOU (n=775), and UPOU (n = 265). There were 13,372 students and 2,194 faculty members among the participants. There were 8,757 females and 6,785 males among the participants, while 24 were identified as neither of the two. Finally, most of the participants were between 21 and 30 years old, while the least number of participants were those that were older than 50.
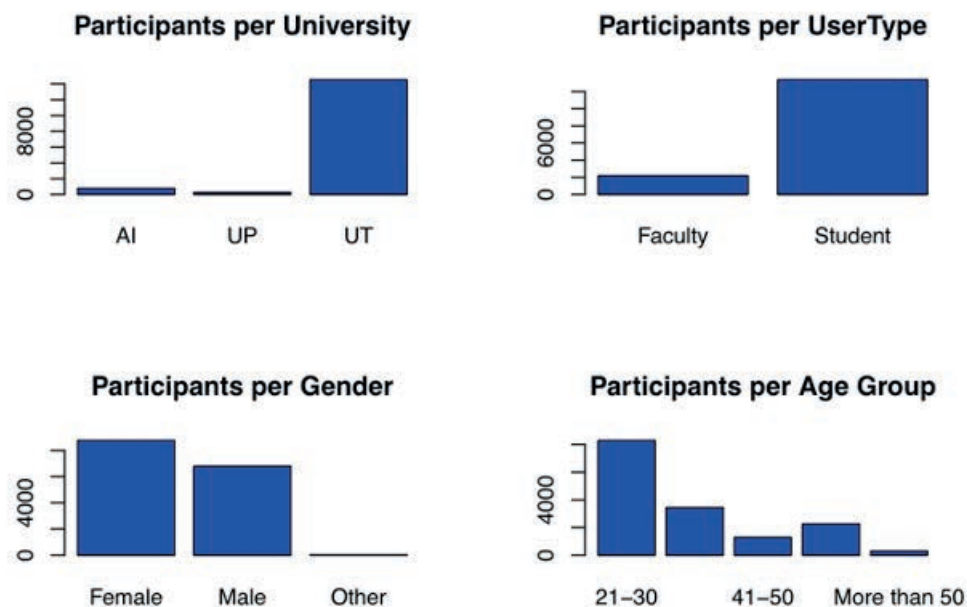

Figure 2. Bar plots of survey participants

Data Collection

Two major instruments were used to collect data. The first instrument was an interview protocol containing questions categorized in three areas: general, LMS-technical, and LMS-academic. General questions included university-related details such as the year it was founded, the number of programs, the number of study centers, and when they started using their LMS. LMS (MOODLE) technical questions included

server details such as the server RAM and operating system, as well as Moodle installation details such as the theme, version, and the availability of some plug-ins like learning analytics or the mobile application. LMS (MOODLE) academic questions were just a checklist of available academic activities that the LMS provided, such as badges, forums, exams, feedback, quizzes, and attendance. These interview protocols were used to interview the three ICT directors.

The second instrument was a survey questionnaire containing the Delone and McLean IS success model items. The online survey was distributed among students and faculty members of the three universities. Each item was operationalized as a Likert-type statement with 1 representing strong disagreement and 5 representing strong agreement.

Data Analysis

Data from the interview was summarized by the authors. Meanwhile, survey data were processed using R-Studio using the R standard libraries (R Core Team, 2012) for statistical analysis and additional libraries like *dplyr* (Wickham, Francois, Henry, & Muller, 2022) for data manipulation and *ggplot2* (Wickham, 2016) for sophisticated plotting. The mean and standard deviation of participants from the three universities were computed for descriptive statistics, while an analysis of variance was used to compute statistical significance. The post-hoc method used to carry out pair-wise comparisons was Tukey's honest significant difference (HSD) as sample sizes were unequal among the three universities.

FINDINGS

We present the findings according to our research objectives.

General and Technical Differences among Universities

The summarized data regarding the general details of each university is presented in Figure 3. AIOU is the oldest among the three universities, while UPOU is the youngest. AIOU is also considered a mega-university with approximately 600,000 enrollments per term, while UPOU only got about 4,000 enrollments. The figure also shows that UT had the most students and faculty members using the learning management system.

General Comparison	AIOU Pakistan	UPOU Philippines	UT Indonesia
Founded	1974	1995	1984
Online / Using MOODLE since	2012	2007	2003
Per Semester Student Enrollments	~ 600000	~4000	302484
No. of Programs	200+	31	38+
No. of Courses	~ 2000	2767	1170
Regional Campuses / Centers	48	3	39 + 1 for Overseas Students
Study / Exam Centers	~ 1172	-	-
Registered Part-time Tutors / Faculty Incharge	~ 96000	445	12000
Online / e-Tutors	464	445	5000
Registered Students on MOODLE	2130	16503	267863
Active Students on MOODLE	1670	6962	120000-150000
Active Tutors on MOODLE	338	253	5000
MOODLE Local Name	OLIVE / AAGHI	MyPortal	UT Online

Figure 3. General information on AIOU, UPOU, UT

The summary in Figure 4 presents data regarding the technical details of the LMS implementation of each university. Both UPOU and UT used the 3.5 version of Moodle while AIOU used 3.3.1 during the data collection period. AIOU was using an Ubuntu Linux distribution while UPOU and UT were both using CENTOS. Among the three universities, UPOU's server utilized the lowest RAM at 24 GB and hard disk space at 192 GB. It was the only university that used outsourced technical support services regarding server

management of the LMS instance. However, it was only AIOU who used their in-house physical servers to host their LMS. Moreover, it was interesting to note that AIOU had its university website developed using ASP classic while UPOU and UT both utilized content management systems like WordPress and Drupal. Mobile applications for their Moodle instance were available for UPOU and UT. Plagiarism plug-ins like Turnitin were in full implementation only in UPOU. None of the three universities had an accessibility or support plug-in for differently-abled students.

MOODLE Technical	AIOU Pakistan	UPOU Philippines	UT Indonesia
MOODLE Version	3.3.1	3.5	3.5
MOODLE Server Type	Physical	Virtual	Virtual
MOODLE Server OS	Ubuntu 16.04	CentOS	Centos 7.5
MOODLE Server RAM	32 GB	24 GB	4x128GB for DB & 4*64GB Web
MOODLE Server HDD	900 GB / 1 TB	192 GB	6TB
MOODLE Learning Analytics	No	No	Yes
MOODLE Mobile Application	No	Yes	Yes
Turnitin / Plagiarism on MOODLE	No	Yes	Limited
MOODLE Technical Administration	In-house	Out-sourced	In-House
MOODLE Hosting	In-house	Cloud	Cloud
Technical Staff Managing the MOODLE	4	1	3
Univesity Website Platform	Classic ASP / SQL Server	Wordpress / PHP / MySQL	Drupal / PHP / MySQL
Accessibility/ Support for Special Students in MOODLE	No	No	No
MOODLE Theme	Standard	Standard	Customized

Figure 4. Technical details of LMS implementation in AIOU, UPOU, UT

The summary in Figure 5 presents data regarding academic details of the LMS implementation of each university.

MOODLE Academic	AIOU Pakistan	UPOU Philippines	UT Indonesia
MOODLE Video Conferecing	BBB	Zoom, Google Hangouts	BBB, Skype4Bussines, MS Teams
MOODLE Badges	No	No	No
MOODLE Competencies	No	No	No
MOODLE Attendance	Yes	No	Yes
MOODLE Quizzes	No	Yes	Yes
MOODLE Assignments	Yes	Yes	Yes
MOODLE Chat	No	Yes	Yes
MOODLE Forums	Yes	Yes	Yes
MOODLE Exam	No	Yes	No
Standardization of Learning Resources	No	No	Yes
Liberty for Tutors to reuse or create their own learning resource	Yes	Yes	Limited
Student Feedback on MOODLE	No	No	Yes
Tutor Feedback on MOODLE	No	No	Yes

Figure 5. Academic details of LMS implementation in AIOU, UPOU, UT

zAIOU solely used Big Blue Button (BBB) as the primary tool for synchronous meetings. UT offered Skype for Business and MS Teams as additional tools while UPOU offered Zoom and Google Hangouts. Only UT provided student and tutor feedback via the LMS.

Satisfaction among LMS Users in Three Universities

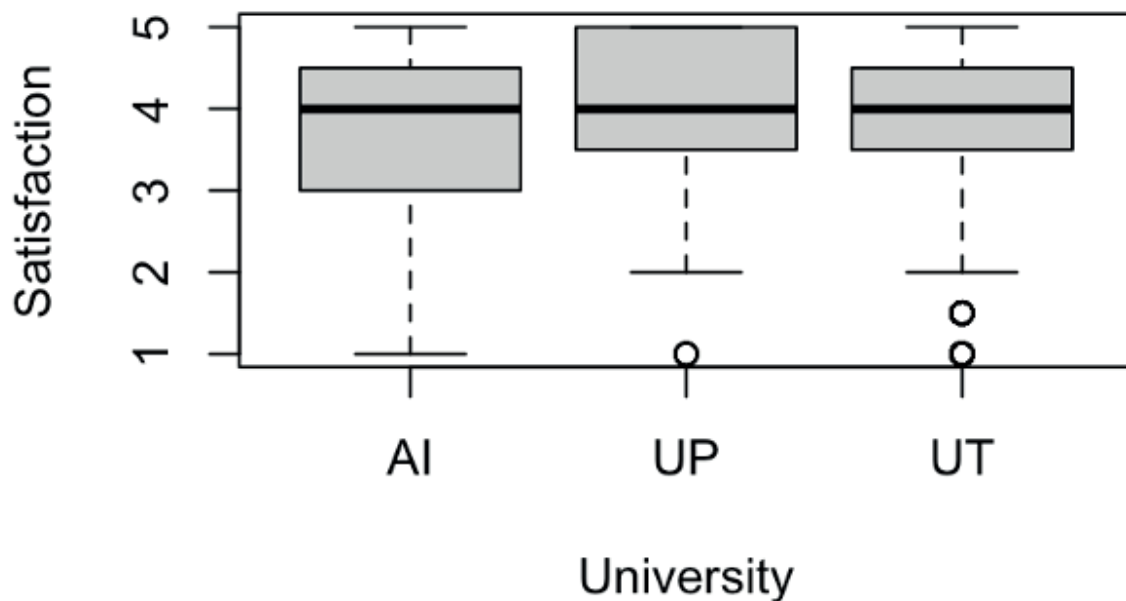Figure 6 shows the boxplot of user satisfaction among three universities.

Figure 6. Boxplots of user satisfaction in LMS implementation among three universities

The analysis of variance resulted in a statistically significant difference in the satisfaction ratings among the three universities [$F(2, 15,563) = 75.57$, $p < .01$]. Post hoc comparisons using the Tukey HSD test indicated that the mean of satisfaction ratings given by participants in UPOU ($M = 3.98$, $SD = 0.94$) and UT ($M = 3.98$, $SD = 0.78$) were significantly higher than the mean of satisfaction ratings from AIOU ($M = 3.54$, $SD = 1.26$) both at $p < 0.01$.

However, the mean satisfaction ratings from UPOU did not significantly differ from the mean ratings from UT.

Intention to Use and Net Benefits among LMS Users in Three Universities

Figure 7 shows the boxplot of intention to use and net benefits among three universities. The analysis of variance resulted in a statistically significant difference in the intention to use ratings among the three universities [$F(2, 15,563) = 12.76$, $p < .01$]. Post hoc comparisons using the Tukey HSD test indicated that the mean of satisfaction ratings given by participants in UPOU ($M = 3.88$, $SD = 0.83$) and UT ($M = 3.68$, $SD = 0.79$) was significantly higher than the mean of ratings from AIOU ($M = 3.60$, $SD = 1.07$) at $p < 0.01$ and $p < 0.05$, respectively.
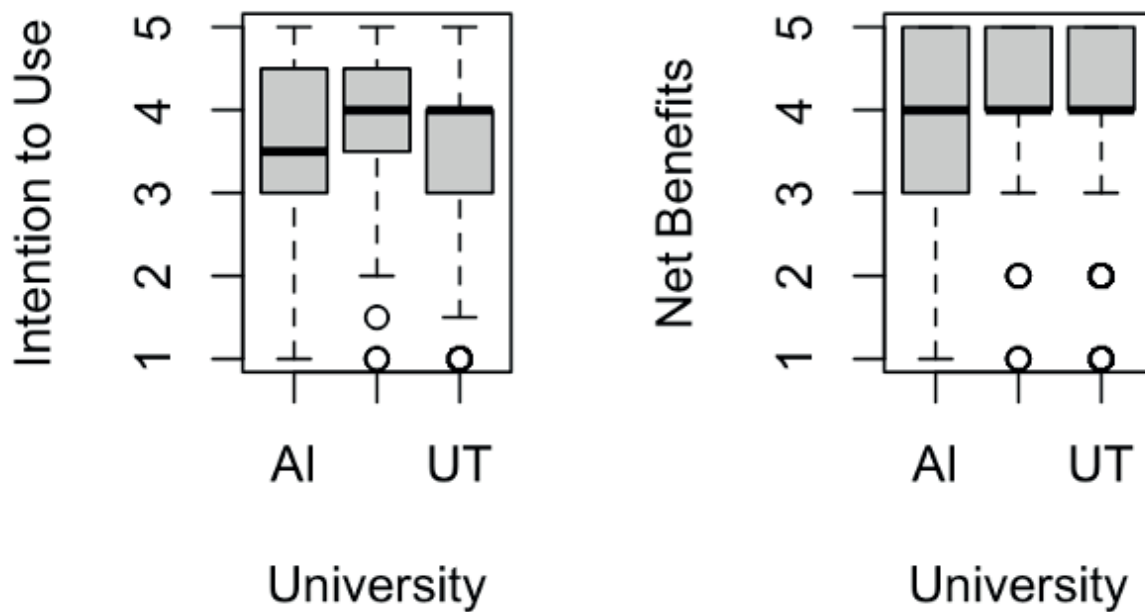
Figure 7. Boxplots of intention to use and net benefits in LMS implementation among three universities

However, the mean intention to use ratings from UPOU did not significantly differ from the mean ratings from UT.

The analysis of variance resulted in a statistically significant difference in the net benefits ratings among the three universities [$F(2, 15,563) = 57.49$, $p < .01$]. Post hoc comparisons using the Tukey HSD test indicated that the mean of satisfaction ratings given by participants in UPOU ($0 = 4.07$, SD = 0.96) and UT ($M = 4.07$, $SD = 0.82$) were significantly higher than the mean of ratings from AIOU ($M = 3.73$, SD = 1.35) both at $p < 0.01$.

However, the mean net benefits ratings from UPOU did not significantly differ from the mean ratings from UT.

Quality among LMS Users in Three Universities

Figure 8 shows the boxplots of information quality, service quality, and system quality in three universities.

The analysis of variance resulted in a statistically significant difference in the information quality ratings among the three universities [$F(2, 15,563) = 29.17$, $p < .01$]. Post hoc comparisons using the Tukey HSD test indicated that the mean of satisfaction ratings given by participants in UPOU ($M = 4.06$, SD = 0.85) and UT ($M = 4.00$, $SD = 0.75$) were significantly higher than the mean ratings from AIOU ($M = 3.79$, SD = 1.08) both at $p < 0.01$.

However, the mean information quality ratings from UPOU did not significantly differ from the mean ratings from UT.
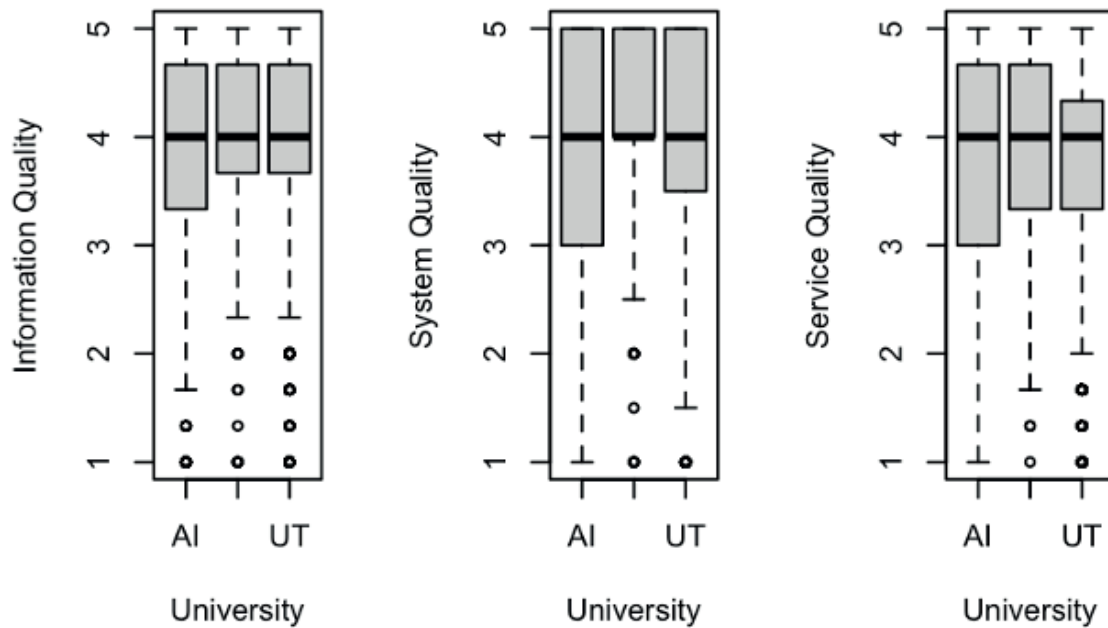
Figure 8. Boxplots of quality in LMS implementation among three universities

The analysis of variance resulted in a statistically significant difference in the service quality ratings among the three universities [F(2, 15,563) = 8.40, p < .01]. Post hoc comparisons using the Tukey HSD test indicated that the mean of satisfaction ratings given by participants in UPOU (*M* = 3.96, *SD* = 0.82) and UT (M = 3.80, *SD* = 0.76) were significantly higher than the mean ratings from AIOU (M = 3.73, SD = 1.09) at p < 0.01 and p < 0.05, respectively. Furthermore, mean service quality ratings from UPOU were statistically significantly higher than ratings from UT at p < 0.01.

The analysis of variance resulted in a statistically significant difference in the system quality ratings among the three universities [F(2, 15,563) = 85.4, p < .01]. Post hoc comparisons using the Tukey HSD test indicated that the mean satisfaction ratings given by participants in UPOU (*M* = 4.14, *SD* = 0.92) and UT (*M* = 4.05, *SD* = 0.77) were significantly higher than the mean ratings from AIOU (0 = 3.67, SD = 1.21) both at p < 0.01.

However, the mean system quality ratings from UPOU did not significantly differ from the mean ratings from UT.

Relationship between Quality, Intention to Use, and Satisfaction

Figure 9 shows a table of effect sizes of correlations between variables. Satisfaction was found to be positively and strongly correlated with information quality, r(15,564) = 0.70, *p* < 0.01; service quality, r(15,564) = 0.76, p < 0.01; and system quality, r(15,564) = 0.69, *p* < 0.01.

Intention to use was found also to be strongly and positively correlated with information quality, r(15,564)=0.55, p < 0.01; service quality, r(15,564)=0.62, p < 0.01; and system quality, r(15,564)=0.69, *p* < 0.01.

Finally, net benefits ratings were found to be strongly and positively correlated with information quality, r(15,564)=0.63, *p* < 0.01; service quality, r(15,564)=0.66, *p* < 0.01; and system quality, r(15,564)=0.62, *p* < 0.01.
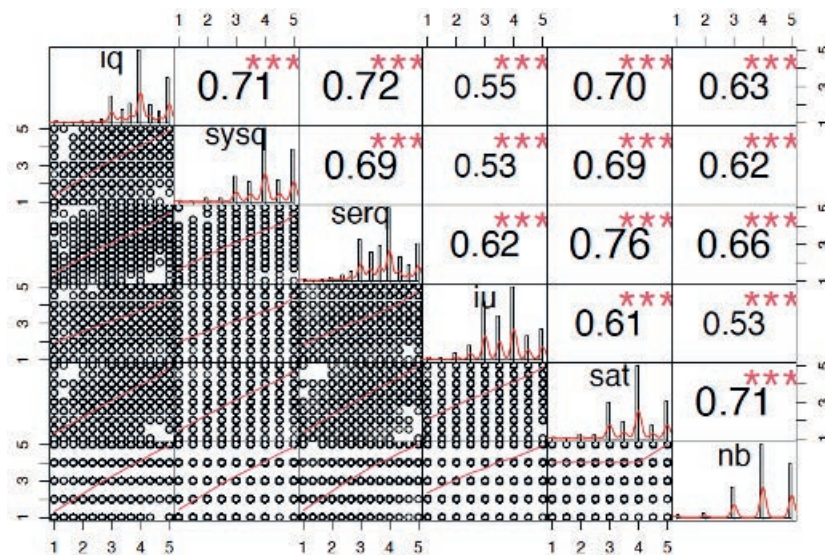
Figure 9. Correlational table of variables

DISCUSSION AND CONCLUSION

This study investigated the implementation of a learning management system among three open universities in Asia before the COVID-19 pandemic began. It highlighted general and technical differences that may have explained the varying degrees of information quality, service quality, system quality, user satisfaction, intention to use, and net benefits which are indicators of the successful implementation of their learning management system.

The general and technical comparison showed that while UPOU was a relatively younger university than AIOU, it was found to be more successful in implementing the LMS based on the significantly higher ratings in all IS success indicators. This could be brought about by the scale by which UPOU started implementing online learning. Rogers (2003) identified time as an important factor for the successful diffusion of innovation like an LMS. Innovativeness or the type of adopters in a university may have determined the success of its LMS implementation. Since UPOU started with the LMS early in 2007, the innovation might have reached the late majority and laggards. The same could be said for UT, which started adopting the LMS in 2003. As for AIOU, they started only in 2012. This could mean that the innovation must have only reached the early adopters which was reflected by the huge difference between the number of users who registered in their LMS (2,130) and their total enrollment per semester (~600,000).

Another factor may have been the in-house implementation of the LMS. Even with a good team, the internet connectivity issues in all three countries may have caused the system quality to suffer. This may have been the case for AIOU in 2019. UPOU and UT used virtual servers that offered redundancy and outsourced maintenance for their LMS. Finally, the service quality ratings of UPOU were significantly higher than those of AIOU and UT which may have been explained by the outsourced technical administration of the LMS. UPOU's ICT center had key people who handle the system administration of the LMS instance. However, its provider was able to help with other technical issues that the university's staff might be too busy to manage. The balance between data privacy and service quality may have been ensured using data privacy, non-disclosure, and other legal agreements. It may also be explained by the population of the university. Both UT and AIOU have been serving a larger population than UPOU. Effective scaling may be a lesson that the smaller university could learn from its more established counterparts.

Moreover, the strong correlations supported the model that was proposed by Delone and McLean. This can be further validated using confirmatory factor analysis and structural equation modeling which are currently outside of the scope of the study

The study showed that AIOU, UPOU, and UT may collaborate to develop or enhance their Learning Management System user interface and user experience. Furthermore, accessibility needs to be enhanced.

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REFERENCES

Armstrong, B., Fogarty, G. J., Dingsdag, D., & Dimbleby, J. (2005). Validation of computer user satisfaction questionnaire to measure IS success in small business. *Journal of Research and Practice in Information Technology*, *37(1), 27-42.*

Bower, M., & Wittmann, M. (2011). A comparison of LAMS and MOODLE as learning design technologies–teacher education students' perspective. *Teaching English with Technology*, *11*(1), 62-80.

Carvalho, A., Areal, N., & Silva, J. (2011). Students' perceptions of Blackboard and Moodle in a Portuguese university. *British Journal of Educational Technology*, *42*(5), 824-841.

Conboy, K., Golden, W., Acton, T., & Halonen, R. (2009, April). DeLone & McLean success model as a descriptive tool in evaluating the use of a virtual learning environment. *International*

Conference on Organizational Learning, Knowledge and Capabilities (OLKC). Conference conducted in Amsterdam, the Netherlands.

Conijn, R., Snijders, C., Kleingeld, A., & Matzat, U. (2016). Predicting student performance from LMS data: A comparison of 17 blended courses using Moodle LMS. *IEEE Transactions on Learning Technologies*, *10*(1), 17-29.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, *19*(4), 9-30.

Hanemann, U. (2019). Examining the application of the lifelong learning principle to the literacy target in the fourth Sustainable Development Goal (SDG 4). *International Review of Education*, *65*(2), 251-275.

Hasan, L. (2019). The usefulness and usability of Moodle LMS as employed by Zarqa University in Jordan. *JISTEM-Journal of Information Systems and Technology Management*, *16*.

Jeljeli, R., Alnaji, L. A., & Khazam, K. (2018). A comparison between Moodle, Facebook, and paper-based assessment tools: Students' perception of preference and effect on performance. *International Journal of Emerging Technologies in Learning, 13*(5).

Lee-Post, A. (2009). e-Learning success model: An information system perspective. *Electronic Journal of e-Learning*, *7*(1), 61-70.

Lengyel, P., Herdon, M., & Szilagyi, R. (2006). Comparison of Moodle and ATutor lmss.Marikar, F. M., & Jayarathne, N. (2016). Effectiveness of Moodle in education system in Sri Lankan University. *International Journal of Modern Education and Computer Science*, *8*(2), 54.

Puri, G. (2012). Critical success factors in e-Learning - An empirical study. *International Journal of Multidisciplinary Research*, *2*(1), 149-161.

Rana, N. P., Dwivedi, Y. K., & Williams, M. D. (2013). Examining the factors affecting intention to use of, and user satisfaction with online public grievance redressal system (OPGRS) in India. *International Federation for Information Processing,* 240-260.

R Core Team. (2012). R: A language and environment for statistical computing. *R Foundation for Statistical Computing.* Vienna, Austria.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press. Sirsat, S. S., & Sirsat, M. S. (2016). A validation of the DeLone and McLean model on the educational information system of the Maharashtra State (India). *International Journal of Education and Learning Systems, 1*, 9-18.

Sun, P.-C., Tsai, R. J., Finger, G., & Chen, Y.-Y. (2007). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 1-20.

Urbach, N., & Muller, B. (2012). The updated DeLone and McLean model of information system success. In Y. Dwivedi, M. Wade, & S. Schneberger (Eds.), *Information system theory* (pp. 1-18). New York, NY: Springer.

Wang, Y. H., Tseng, Y. H., & Chang, C. C. (2013, October). Comparison of students' perception of Moodle in a Taiwan university against students in a Portuguese university. In *International Conference on Web-Based Learning* (pp. 71-78). Springer, Berlin, Heidelberg.

Wickham, H. (2016). Data analysis. In *ggplot2* (pp. 189-201). Springer, Cham.

Wickham, H., Francois, R., Henry, L., & Muller, K. (2022). dplyr: A grammar of data manipulation. R package version 0.4. 3. *R Foundation for Statistical Computing*. Vienna, Austria.

Wu, J. H., & Wang, Y. M. (2006). Measuring KMS success: A respecification of the DeLone and McLean's model. *Information and Management*, *43*(6), 728-739.

Zolait, A. H. (2010). An examination of the factors influencing Yemeni Bank users' behavioural intention to use Internet banking services. *Journal of Financial Services Marketing*, *15*(1), 76-94.

Zolait, A. H., & Mattila, M. (2009). UIBR - An approach to innovations acceptance. *Journal of Internet Banking and Commerce,* 1-17.