Investigating Digital Library Success using the DeLone and McLean Information System Success 2.0: The Analysis of Common Factor based Structural Equation Modeling

Asyraf Afthanorhan¹, Hazimi Foziah¹, Norlana Abd Majid¹

¹Faculty of Business and Management, University of Sultan Zainal Abidin, 21300 Kuala Nerus Terengganu, Malaysia

nikhazimi@unisza.edu.my

Abstract. In many years, libraries from government universities spent a vast amount of investment to subscribe to various digital resources such as online reputable publishers, journals, online databases, books, monographs, and other resources for information storage. However, prior studies reported that the utilization of digital library is remain lacking though online libraries were able successfully find the necessary information. This is confirmatory study to model and investigating the determinant of user satisfaction of a digital library system. A research model was adopted from an existing model as Delone and McLean Information System success 2.0. Data were collected using cluster sampling technique. A total of 353 usable questionnaires were used for empirical study purpose. The results showed that Information Quality is the strongest effect in contributing the user satisfaction followed by the quality factors (System Quality and Service Quality). In additions, the Preacher & Hayes approach was used for testing the indirect effect. From this approach, partial mediation was occurred in all effects. Briefly, the behavioural intentions are greatly influenced by the quality factors and Information System.

Keywords: DeLone and McLean Information System Success, Structural Equation Modeling, Preacher and Hayes Approach, User Satisfaction, Behavioural Intentions

1.0 Introduction

The rapid growth of the Information and Communication Technology (ICT) has become the main platform for various activities and job, e.g. selling online, purchasing, chatting, video calling, marketing, sharing online and other databases for the users. That is, more information can be obtained from these resources to expedite the information process through electronic forms such as emails, online report, videos, WhatsApp, telegrams and other resources that may go beyond the library services. [1] stated that most of the users spend up to almost 40% of their time searching for relevant information. This great amount of internet without the time constraint has led to a significant usefulness on Digital Library in almost a decade.

The concept of libraries has been known across the world in hundred years and there are often regarded as information collectors. Their roles were increased recently when the internet recently has becoming easily accessible to across nations. As a result, the development of technology was increasing tremendously every year which led to many benefits for digital libraries. According to [2], the digital libraries has been widely used in many countries that can assists the user to get the
information timely. Moreover, [3] contemplated that more than 10% students in the online condition were able to find the relevant resources for their study compare to face to face instructional learning. In additions, they also able to complete the given task with more informative and creative. However, prior studies reported that the utilization of digital library is remain lacking though online libraries were able successfully find the necessary information.

This research paper is aimed to evaluate the DeLone & McLean Information System Success Model 2.0 in the context of digital library in Malaysia. Also, this study provides some insights into society perception of digital libraries and creates an understanding to improve the user’s satisfaction. The rest of this papers is organized as follows. In the next topic, we provide briefly about the Delone and McLean Information System Success. Then, a conceptual model was displayed for empirical research purposes. Finally, we discussed the findings and outline several limitations of our study for improvement in the future.

2.0 Literature Review

2.1 DeLone & McLean Information System Success Model 2.0

The measurement Information System success was developed by Delone and McLean in the early of 1990. That model was recognized as D&M IS success model that composed with six latent variables: System Quality, Information System, Individual Impact, Use, Organizational Impact and Users Satisfaction. This model actually was developed from three layers of information [4] and extension of level by [5].

Historically, the Delone and McLean IS model was often criticized since it was developed due to lack of variables in the model and not recommended for the success model [6],[7]. After 10 years of research and modification based on many contributors, the new model of Delone and McLean was proposed in 2002. This new model was reformed by inclusion the Service Quality construct to measure the users behaviour. In the end, they emerged the Individual Impact and Organizational Impact as Net Benefits. Since then, this model was widely used in digital libraries, knowledge management system, management information system and online learning systems. Therefore, this study has focus to service quality, information quality, system quality, intention to use and user satisfaction as shown in Figure 1. Hence, the research hypotheses for this study are:

H1: Information System has positive significant effect on Intention to Use
H2: System Quality has positive significant effect on Intention to Use
H3: Service Quality has positive significant effect on Intention to Use
H4: Information System has positive significant effect on User Satisfaction
H5: System Quality has positive significant effect on User Satisfaction
H6: Service Quality has positive significant effect on User Satisfaction
H7: Intention to Use has positive significant effect on User Satisfaction

Figure 1: Theoretical Framework
3.0 Data Collection Procedure
To obtain the relevant sample size for this study, the two approaches were applied. First, Gpower software was used. The maximum of four predictors were allowed with 0.02 of effect size and 0.80 of statistical power. From this calculations, the sample size was determined up to 385. Second, the [8] approach was selected to assure the consistency of the sample size determination. Using this approach, the number of observed variables in the research model was multiplied with 5 and 10. In this case, with 27 of observed variable, the acceptable range for the sample size was fall between 135 and 270. Therefore, data were collected greater than the number required to avoid the insufficient of sample size that can led to bias results. We implement one stage process for data collections as recommended by [9] and [10]. The 400 structure questionnaire were administered to three government institutions using the cluster sampling. During this process, the respondents were asked with screening question which was “Are you use the digital library system in your organisational?”. All respondents were given 10-15 minutes to answer the questions. A total of 353 complete responses were collected (88.25% of response rate) and be used for subsequent analysis.

3.1 Variables and Measurement
The observed variable of the constructs was fully adapted from various studies in the literatures. Some of the newly observed variable was added in certain construct to increase the meaning of construct. The observed variable for system quality construct was taken from [11],[12], and [13]. In the case for service quality construct, the five observed variables actually represented from dimensions that are focused on empathy, response, reliability, tangible and assurance. All observed variable under service quality were computed to reduce the model complexity. Those observed variable were adapted from [14] and [15]. For information quality, all observed variable were devised by [13] but has been modified based on suitability for the research scope. For endogenous construct, the user satisfaction was assessed by 5 observed variables from [16] and [17] which are US1, US2, US3, US4 and US5. All observed variables were asked related to user experience on digital library. Lastly, the behavioural intention or intention to use was measured by 6 items which are IU1, IU2, IU3, IU4, IU5, and IU6. Those observed variables were formed by [18] and [19]. All measurement observed variable uses 10 point of Likert scale ranging from strongly disagree to strongly agree at the end point.

4.0 Findings
In our study, we are plan to use common factor based structural equation modelling or sometimes regarded as covariance based structural equation modelling to test the proposed relationships between construct in the model. Structural Equation Modeling (SEM) has become a method of choice in social sciences, management, marketing, tourism, supply chain and so forth. It allows the researchers to model multiple exogenous and endogenous construct in a single model with various approaches. To analyse the model with this method, it incorporates IBM-SPSS AMOS 22.0 software. In line with [20] approach, the measurement model was tested in terms of the construct reliability and validity. From that, the model was re-adjusted as structural model to evaluate the hypothesis and estimating the parameter estimates [21]. This study uses Preacher & Hayes approach to evaluate the mediation effect as often recommended due to their accuracy in estimate the standard error of path coefficients.

4.1 Descriptive Analysis
Table 1 shows the demographic representation of the respondents. From the descriptive results, the sample for male and female was approximately 34.3% and 65.7% which showing that the ratio of female was greater than of the male in government institute. In additions, majority of student whose using the digital system was from Bachelor (54.1%), Diploma (35.7%), Master/PhD (1.9%) and Others (7%). In the case of user spent per week, majority of the user spent their time with digital library system below than 1 hour (66.9%). Approximately 44.7% of users are using this service below than 2 times per week, 32.9% used the digital library for 3-4 weeks per week, 15.6% used it for 5-7 times per week, and about 6.7% of users had more than 8 times per week.
Table 1. Respondents Profile

|                | Frequency | Percent |
|----------------|-----------|---------|
| **Gender**     |           |         |
| Male           | 121       | 34.3    |
| Female         | 232       | 65.7    |
| **Education**  |           |         |
| Diploma        | 126       | 35.7    |
| Bachelor       | 191       | 54.1    |
| Master/ PhD    | 29        | 8.2     |
| Others         | 7         | 1.9     |
| **Hour spent per week** |       |         |
| Less 1 hour    | 236       | 66.9    |
| 1-5 hours      | 87        | 24.6    |
| 6-10 hours     | 22        | 6.2     |
| More than 10 hours | 8     | 2.2     |
| **Time used per week** |       |         |
| < 2 times a week | 158      | 44.7    |
| 3-4 times a week | 116      | 32.9    |
| 5-7 times a week | 55       | 15.6    |
| 8 times a week and above | 24 | 6.7     |

4.2 Measurement Model

Following to [20] practice, we assessed the convergent validity by examining the Average Variance Extracted (AVE), Maximum Shared Variance (MSV) and Maximum Rho (MaxR). For construct reliability in a model, the Composite Reliability (CR) was calculated. After that, the model is evaluated with establishing the discriminant validity (Fornell-Larcker approach). All assessments were suggested that AVE > 0.50, MSV < AVE, MaxR(H) > MSV and CR > 0.70 [22],[23],[24].

As shown in Table 2, the value of AVE was greater than the threshold value of 0.50, and the CR was more than 0.70. Apart from that, the value from MSV is lower than the value from AVE and MaxR(H) is concluded higher than the value of MSV. The factor loading from each construct was higher than 0.60 [17],[21] which were in the ranges of Information System (0.75-0.88), System Quality (0.74-0.88), Service Quality (0.78-0.88), Intention to Use (0.62-0.74) and User Satisfaction (0.73-0.77). For the model validity, the Chisq/df, RMSEA, CFI, IFI and TLI were selected in that they are more recommended for measurement model assessment. These fitness indexes were achieved as the suggested values e.g. Chisq/df = 1.621, RMSEA = 0.042 < 0.08, CFI = 0.970 > 0.95, IFI = 0.971 > 0.95, and TLI = 0.967 > 0.95.

According to [25] the new measure of Heterotrait-Monotrait (HTMT) ratio was proposed to replace the conventional measure as Fornell-Larcker but the method itself only compatible with the composite method as Partial Least Squares Path Modeling (PLS-PM). Discriminant validity implies the uniqueness of each construct applied in a model which displays their position are not correspond to each other within the same model. According to [26], the value of construct correlations was compared with the square root value of AVE. The purpose of doing this approach to explain the model are free from the redundancy problem as depicted in Table 2. The discriminant validity was achieved as the square root value of AVE is higher than the construct correlations.

Table 2. Reliability and Validity Results

|                | CR   | AVE  | MSV  | MaxR(H) | Intention Use | Information System | System Quality | Service Quality | User Satisfaction |
|----------------|------|------|------|---------|---------------|--------------------|----------------|-----------------|-------------------|
| Intention Use  | 0.905| 0.656| 0.298| 0.917   | 0.810         |                    |                |                 |                   |
| Information System | 0.905| 0.657| 0.269| 0.913   | 0.519         | 0.811              |                |                 |                   |
| System Quality  | 0.907| 0.661| 0.298| 0.916   | 0.546         | 0.490              | 0.813          |                 |                   |
4.3 Structural Model

Subsequently, the proposed hypothesis were tested by executing the full information maximum likelihood estimator (FIML) as suggested by [27] to avoid the improper solution and non-convergence estimates. The common factor based SEM does not rely the bootstrap application to produce the standard error of parameter estimates. Because the estimator applied was regarded as the best linear unbiased estimator (BLUE) which can yield their own standard error [28],[29]. The results is presented in Table 3.

| Service Quality | User Satisfaction |
|-----------------|-------------------|
| 0.912           | 0.869             |
| 0.676           | 0.571             |
| 0.241           | 0.257             |
| 0.919           | 0.870             |
| 0.427           | 0.507             |
| 0.469           | 0.412             |
| 0.491           | 0.431             |
| 0.822           | 0.465             |
|                 | 0.755             |

Figure 2 shows the value for each path in a model. The $R^2$ for user satisfaction and intention to use are above 0.26 as recommended by [30] and [31] to be substantial. Specifically, the $R^2$ for User satisfaction was 0.34 or 34% and for Intention to Use was 0.52 or 52% which exceeded the 0.26. As predicted, the following quality factor has positive effect on Intention to Use: Information System ($\beta = 0.349$, $p< 0.001$), System Quality ($\beta = 0.428$, $p< 0.001$) and Service Quality ($\beta = 0.126$, $p< 0.05$), supporting H1, H2, and H3. Next, the two quality factors were not positively significant on user satisfaction as follows: Information System ($\beta = 0.090$, $p>0.05$) and System Quality ($\beta = 0.105$, $p>0.05$) which not supporting H4 and H5. Hence, only one of the quality factor that is Service Quality has positive on User Satisfaction ($\beta = 0.210$, $p< 0.001$) which supporting H6. Next, the last part was testing the relationship between Intention to Use and User Satisfaction (H7) and it was shown supported ($\beta = 0.245$, $p< 0.001$).
Table 3. Structural Model Results

|                      | Estimate | S.E. | C.R. | P     | Result   |
|----------------------|----------|------|------|-------|----------|
| Intention Use        | .349     | .072 | 4.867 | ***   | Significant |
| System               |          |      |       |       |          |
| Intention Use        | .428     | .078 | 5.477 | ***   | Significant |
| System Quality       |          |      |       |       |          |
| Intention Use        | .126     | .062 | 2.037 | .042  | Significant |
| Service Quality      |          |      |       |       |          |
| User Satisfaction    | .090     | .064 | 1.388 | .165  | Not Significant |
| Information System   |          |      |       |       |          |
| User Satisfaction    | .105     | .070 | 1.493 | .135  | Not Significant |
| System Quality       |          |      |       |       |          |
| User Satisfaction    | .210     | .055 | 3.795 | ***   | Significant |
| Service Quality      |          |      |       |       |          |
| User Satisfaction    | .245     | .057 | 4.295 | ***   | Significant |
| Intention Use        |          |      |       |       |          |

Moreover, the Preacher & Hayes approach also conducted to testing the indirect effect. This approach entails the bootstrap maximum likelihood (Bootstrap ML) and 1000 of resampling to generate the standard error for indirect effect simultaneously. The results showed that Intention to Use has mediates the effect of Information System, System Quality and Service Quality with User Satisfaction which supporting H8, H9, and H10. In the case of the type of mediation, Intention to Use was predicted as partial mediator in the relationships between Service Quality and User Satisfaction, whereas the Intention to Use become full mediator for the relationships between Information System and User Satisfaction and lastly for the System Quality and User Satisfaction as depicted in Table 4.

Table 4. Indirect Effect Results

|                      | Direct Effect | Indirect Effect | Type of Mediation |
|----------------------|---------------|-----------------|-------------------|
| Information System   | 0.055(0.439)  | 0.084(0.002)    | Full Mediation    |
| Intention Use        | Not Significant | Significant     |                  |
| User Satisfaction    |               |                 |                  |
| System Quality       | 0.094(0.188)  | 0.102(0.001)    | Full Mediation    |
| Intention Use        | Not Significant | Significant     |                  |
| User Satisfaction    |               |                 |                  |
| Service Quality      | 0.282(0.002)  | 0.036(0.044)    | Partial Mediation |
| Intention Use        | Significant   |                 |                  |
| User Satisfaction    |               |                 |                  |

*values in the parenthesis is the p-values

5.0 Discussion and Conclusion

The purpose of this study was to evaluate and testing Delone and McLean Information System Success 2.0 that affect the digital libraries in government institutions. This study using the confirmatory method with common factor based SEM to answer the research questions. The empirical findings showed that 8 out of the 10 proposed hypotheses were supported. The two hypotheses that are not supported were about the relationships between Information System, System Quality and User Satisfaction. To add, the mediator of Intention to Use was truly has effect in between the quality factors and User Satisfactions. In additions, the empirical finding also highlighted that Intention to Use was fully utilized when Information System and System Quality were applied.

In terms of the theoretical contribution, this research provided the validity of Delone and McLean Information System in the context of digital library. Second, most the prior studies have great attention
on individual impact and e-library adoption but very few study has aimed to assess the User Satisfaction in terms of various quality factors. For the practical implication, this study can offer the decision maker to improve their quality of services by providing some recommendation to focus on Service Quality factor. This is because the empirical finding showing that Service Quality is the only factor can have an effect on User Satisfaction. Second, the decision maker should focus to the Intention to Use factor as it was indicated important in all the effects in the model.

Some of the limitations are inherit in this study. First, this study focus on government institution which means cannot generalize to all institution in Malaysia. With this narrow scope, the results may not consistent due to different cultural and background. Second, the observed variable applied in the current study was based on existing model which some of the observed variable may not compatible when the research scope has been enlarge. Third, this study uses survey questionnaire and the quantitative method was conducted to investigate the relationship among factors in a model. The result may be more accurate if the mixed method (qualitative and quantitative) is conducted for a comprehensive investigations of user satisfaction. Finally, the result might be changed when the longitudinal study is conducted which focuses on same sample with different time.

6.0 Declaration of Conflicting Interest
The authors declared no conflict of interest with the research and publication of this paper.

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