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Measuring the Success of E-learning at SMA Negeri 1 Kroya by Adopting the Delone and McLean Model

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Keywords

E-learning; information systems success; DeLone and McLean model; user satisfaction; secondary education.

Abstract

This study aims to measure the success of the e-learning system implemented at SMA Negeri 1 Kroya by adopting the DeLone and McLean Information Systems Success Model. A descriptive quantitative approach was employed, with data collected through observations, interviews, and questionnaires distributed to 300 students selected randomly from a population of 1,004 students. The data were analyzed using Structural Equation Modeling (SEM) with the SmartPLS software. The evaluation focused on six constructs: system quality, information quality, service quality, system use, user satisfaction, and net benefits. The results indicate that the model has adequate explanatory power in explaining system use, user satisfaction, and net benefits. Hypothesis testing shows that information quality and service quality significantly affect system use, while system quality and information quality significantly influence user satisfaction. In addition, system use and user satisfaction have a significant impact on net benefits. However, system quality does not significantly affect system use, and service quality does not significantly influence user satisfaction. Indirect effect analysis reveals that user satisfaction plays a more dominant mediating role than system use. These findings highlight that user satisfaction and quality of experience are key factors in determining the success of e-learning implementation.

Introduction

The development of information and communication technology (ICT) has had a significant impact on various sectors, including education. One form of ICT utilization in education is e-learning, which enables the implementation of learning and exams online without being constrained by space and time. E-learning facilitates access to learning materials and provides flexibility for both students and teachers in the educational process (Ally, 2008). SMA Negeri 1 Kroya, located in Cilacap Regency, is one of the educational institutions that has implemented e-learning to support the quality of learning and the implementation of academic exams, demonstrating its commitment to the modernization of education.

However, despite its great potential, the implementation of e-learning at SMA Negeri 1 Kroya faces several challenges. One of the main issues is the technical problems that occur in the Learning Management System (LMS), especially during the mid-term exams (PTS) and final exams (PAS). System instability, which often arises during simultaneous access and content display issues, disrupts the learning process. As a result, both teachers' and students' motivation to use e-learning decreases, and the inefficient allocation of resources for system improvements leads to a reactive approach that does not focus on addressing the root cause (Ally, 2008; Wang, 2019).

In addition to technical issues, SMA Negeri 1 Kroya also lacks a comprehensive evaluation system to measure the overall success of e-learning. The evaluations conducted so far have focused mainly on technical aspects and have not used a framework that provides a holistic view of e-learning effectiveness. As a result, it remains unclear which factors have the most significant influence on the success of e-learning implementation, whether it is related to system quality, information quality, service quality, or other factors. For example, Handayani and Wiyata (2020) found that system quality and service quality play a crucial role in learning effectiveness and user satisfaction. However, there is no clear understanding of how these factors influence the success of e-learning implementation at SMA Negeri 1 Kroya.

To address these issues, this study aims to measure the success of e-learning at SMA Negeri 1 Kroya by adopting the Delone and McLean model. This model is chosen because it provides a comprehensive perspective for evaluating information systems, including e-learning, by considering various aspects such as system quality, information quality, service quality, system usage, user satisfaction, and the impact on learning outcomes. This research is expected to provide a clear understanding of the factors influencing the success of e-learning at SMA Negeri 1 Kroya, which can serve as a basis for more targeted and sustainable improvements in e-learning implementation.

Method

This study uses a descriptive quantitative approach to measure the success of e-learning at SMA Negeri 1 Kroya. The study focuses on the aspects within the Delone and McLean model, namely: system quality, information quality, service quality, system usage, user satisfaction, and its impact on learning outcomes.

The population of this study consists of all students at SMA Negeri 1 Kroya who use the e-learning system, totaling 1,004 students from grades X, XI, and XII. The sample for this study was taken using the **Random Sampling** method, where every member of the population has an equal chance of being selected as a respondent. Based on the Slovin formula, the required sample size is 286 respondents, which was then rounded up to 300 respondents to ensure representativeness and efficiency in data collection.

After the data is collected, the next step is to conduct data analysis. The data obtained from observations, interviews, and questionnaires will be analyzed using SmartPLS software to perform Structural Equation Modeling (SEM). The analysis process includes evaluating the Measurement Model (Outer Model), in which the researcher tests the validity and reliability of the indicators used in the questionnaire. Convergent validity is assessed to ensure that the indicators accurately represent the constructs being measured, while reliability testing is conducted to confirm their internal consistency. Discriminant validity is then examined to ensure that the latent constructs are empirically distinct from one another, using the cross-loading method and the Fornell–Larcker criterion. After the measurement model is validated, the Structural Model (Inner Model) is evaluated to test the relationships between latent variables. This includes assessing Predictive Relevance (Q^2), where values greater than 0 indicate good predictive capability, with thresholds of 0.35 (strong), 0.15 (moderate), and 0.02 (weak). The Goodness of Fit (GoF) index is also calculated to determine the overall model fit, with values above 0.67 indicating good fit, between 0.33 and 0.67 indicating moderate fit, and below 0.33 indicating poor fit. Finally, hypothesis testing is performed using the bootstrapping technique to determine the significance of the relationships between variables. Hypotheses are evaluated using t-statistics and p-values, where a t-statistic greater than 1.96 and a p-value less than 0.05 indicate acceptance of the hypothesis, whereas values outside these thresholds lead to hypothesis rejection.

Based on the conceptual model developed, the hypotheses tested in this study include:
H1: System quality significantly affects the usage of the e-learning system.
H2: System quality significantly affects user satisfaction with the e-learning system.
H3: Information quality significantly affects the usage of the e-learning system.
H4: Information quality significantly affects user satisfaction with the e-learning system.
H5: Service quality significantly affects the usage of the e-learning system.
H6: Service quality significantly affects user satisfaction with the e-learning system.
H7: Usage significantly affects user satisfaction with the e-learning system.
H8: Usage significantly affects the net benefits of the e-learning system.

Results and Discussion

1. Evaluation of the Measurement Model (Outer Model)
    a. Validity Test
        1) Convergent Validity Test

This test aims to assess the extent to which indicators are able to represent the variables they are intended to measure. According to Artha et al. (2022), an ideal loading factor value should be above 0.70. However, values between 0.50 and 0.70 are still acceptable as long as two conditions are met: the Average Variance Extracted (AVE) value is greater than 0.50**,** and the indicator has theoretical relevance in explaining the variable being measured.

Table 1. Outer Loadings Value

Variable	Indicator	Loading Value	Result
Sistem Quality	SQ1	0.726	Valid
	SQ2	0.645	
	SQ3	0.775	
	SQ4	0.751	
Information Quality	IQ1	0.819	Valid
	IQ2	0.873	
	IQ3	0.800	
	IQ4	0.794	
Service Quality	SEQ1	0.883	Valid
	SEQ2	0.870	
	SEQ3	0.869	
Use	U1	0.529	Valid
	U2	0.943	
User Satisfaction	US1	0.866	Valid
	US2	0.900	
Net Benefit	NB1	0.906	Valid
	NB2	0.870	
	NB3	0.861	

Table 1 shows that all indicators in this research model have outer loading values above 0.50, which is the minimum threshold for convergent validity. Most indicators even have values above 0.70, indicating that the constructs have been measured consistently and relevantly by their respective indicators. Therefore, all indicators are declared valid, and none need to be removed from the model. This demonstrates that the measurement instruments used are capable of accurately representing the latent constructs.

In addition, construct validity can also be assessed through the Average Variance Extracted (AVE) value, which indicates how much variance of the indicators is explained by the latent construct. Referring to Artha et al. (2022), a construct is considered to have good convergent validity if the AVE value exceeds 0.50. The AVE values for each construct are as follows.

Table 2. Average Variance Extracted (AVE) Value

Construct	***Average Variance Extracted* (AVE)**
Sistem Quality	0.527
Information Quality	0.676
Service Quality	0.764
Use	0.585
User Satisfaction	0.780
Net Benefit	0.773

Table 2 shows that all latent variables in this study have Average Variance Extracted (AVE) values above 0.50. This indicates that each variable can explain more than 50% of the variance of the indicators that measure it. Thus, all constructs have met the convergent validity criteria proposed by (Artha et al. 2022) and are therefore suitable to be used in the subsequent structural model analysis.

2) Discriminant Validity Test

The discriminant validity test aims to ensure that each construct in the model is truly distinct and measures different aspects that are not overlapping with one another. This test is essential to confirm that each construct does not have an excessively high correlation with other constructs that should not be directly related.

In general, there are two common methods used to assess discriminant validity: comparing cross-loading values between indicators and applying the Fornell-Larcker criterion.

In the cross-loading method, an indicator is considered valid in terms of discriminant validity if its loading value on the construct it represents is higher than its loading value on other constructs. In other words, the indicator should show the strongest relationship with its intended latent variable.

Table 3. Cross Loading Value

	Information Quality (X2)	*Net Benefit* (Y)	*Service Quality* (X3)	*Sistem Quality* (X1)	*Use* (Z1)	*User Satisfaction* (Z2)
IQ1	0.819	0.486	0.490	0.553	0.396	0.534
IQ2	0.873	0.505	0.521	0.471	0.375	0.547
IQ3	0.800	0.501	0.442	0.507	0.298	0.509
IQ4	0.794	0.578	0.482	0.597	0.394	0.571
NB1	0.558	0.906	0.504	0.427	0.552	0.684
NB2	0.595	0.870	0.478	0.428	0.492	0.634
NB3	0.515	0.861	0.421	0.409	0.619	0.636
SEQ1	0.502	0.463	0.883	0.438	0.409	0.534
SEQ2	0.521	0.436	0.870	0.465	0.349	0.554
SEQ3	0.525	0.494	0.869	0.470	0.315	0.581
SQ1	0.492	0.364	0.380	0.726	0.218	0.370
SQ2	0.339	0.255	0.277	0.645	0.135	0.344
SQ3	0.476	0.333	0.449	0.775	0.198	0.399
SQ4	0.548	0.416	0.399	0,751	0.245	0.466
U2	0.474	0.615	0.415	0.302	0.943	0.560
UI	0.102	0.286	0.144	0.051	0.529	0.280
US1	0.524	0.625	0.518	0.411	0.518	0.866
US2	0.633	0.682	0.601	0.550	0.511	0.900

Table 3 shows that each indicator has the highest loading value on its original construct compared to other constructs, indicating that discriminant validity has been achieved.

Furthermore, discriminant validity was also tested using the Fornell-Larcker method. In this approach, validity is considered to be established if the correlation value of a construct with itself (as represented by the diagonal values in the table) is greater than its correlations with other constructs.

Tabel 4. Fornell-Larcker's Criterion Value

	Information Quality (X2)	*Net Benefit* (Y)	*Service Quality* (X3)	*Sistem Quality* (X1)	*Use* (Z1)	*User Satisfaction* (Z2)
Information Quality (X2)	0.822					
Net Benefit (Y)	0.631	0.879				
Service Quality (X3)	0.590	0.531	0.874			
Sistem Quality (X1)	0.649	0.479	0.523	0.726		
Use (Z1)	0.447	0.632	0.409	0.280	0.765	
User Satisfaction (Z2)	0.659	0.741	0.636	0.549	0.582	0.883

Table 4 shows that each variable in this study has the highest correlation value when compared with itself rather than with other variables. For example, the correlation value for the SQ variable is higher compared to other variables such as IQ, SEQ, U, US, and NB. These results indicate that each construct in this model has met the discriminant validity criteria according to the Fornell-Larcker criterion.

b. Reliability Test

The reliability test aims to evaluate how consistent and dependable the research instrument is. An instrument with good reliability will produce stable data even when used repeatedly for measurement. One of the methods used to assess reliability is through the Cronbach's Alpha value. The criteria for determining reliability based on Cronbach's Alpha are as follows: If the Cronbach's Alpha value is above 0.60, the instrument is considered reliable. If the value is below 0.60, the instrument is considered unreliable. The results of the reliability testing for all variables in this study can be seen in Table 5 below.

Tabel 5. Reliability Test Result

Variable	***Composite Reliability***	***Cronbach's Alpha***	**Result**
Information Quality (X2)	0.893	0.840	Reliable
Net Benefit (Y)	0.911	0.853	Reliable
Service Quality (X3)	0.906	0.845	Reliable
Sistem Quality (X1)	0.816	0.702	Reliable
Use (Z1)	0.723	0.357	Not Reliable
User Satisfaction (Z2)	0.876	0.719	Reliable

Based on Table 5, the results show that all variables have Composite Reliability values above 0.7, indicating that the instruments are sufficiently stable and reliable in measuring the constructs. However, when assessed using Cronbach's Alpha, five out of the six variables have values above the threshold (≥ 0.6), except for the Use variable, which only obtained a value of 0.357. Therefore, according to internal reliability criteria, this variable is considered unreliable. Thus, it can be concluded that although the variables in this study are generally reliable, further evaluation or improvement of the indicators in the Use variable is needed to enhance internal consistency in future research.

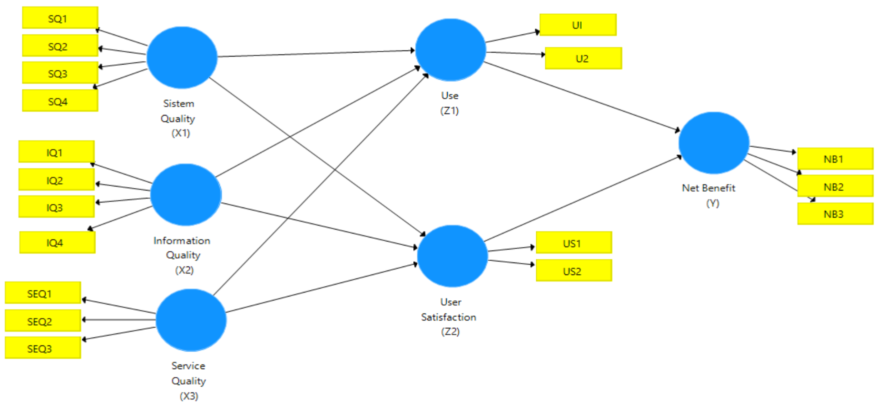

Figure 1. PLS Algorithm Model

Figure 1 shows the results of the evaluation of the measurement model (outer model). Based on the testing process for indicator validity and reliability, this research model can be categorized as having statistically adequate quality. Therefore, the results of the outer model evaluation indicate that the instrument used has met the required feasibility criteria, allowing the analysis to proceed to the next stage, namely the evaluation of the structural model (inner model).

2. Evaluation of the Structural Model (Inner Model)
   a. Coefficient of Determination (R Square or R^2)

The coefficient of determination, known as R^2, is used to assess the extent to which independent variables can explain dependent variables in a structural model. The R^2 value indicates how much variability in the endogenous construct can be explained by the exogenous constructs. The interpretation criteria for R^2 according to Hair et al. (2022) are as follows: $R^2 \geq 0.75$ High; $R^2 \geq 0.50 - < 0.75$ Moderate; $R^2 \geq 0.25 - < 0.50$ Low; $R^2 < 0.25$ Very Low

R^2 values range between 0 and 1, where values closer to 1 indicate better predictive accuracy of the model in predicting endogenous constructs. The results of the R^2 testing for each variable in the model are shown in Table 6, which illustrates the extent to which exogenous variables jointly explain the dependent variables.

Table 6. Coefficient of Determination Results

Variabel	*R Square*	Result
Net Benefit (Y)	0.610	**Moderate**
Use (Z1)	0.236	**Very Low**
User Satisfaction (Z2)	0.536	**Moderate**

Table 6 shows the R^2 values for each dependent variable in the model. The Net Benefit variable has an R^2 value of 0.610, which falls under the moderate category. This indicates that the model can explain around 61.0% of the variation in perceived net benefits, while the remaining 39.0% is influenced by variables outside the model. Next, the User Satisfaction variable has an R^2 value of 0.537, also in the moderate category. This means that System Quality, Information Quality, and Service Quality collectively explain 53.6% of the variation in user satisfaction. Meanwhile, the Use variable has an R^2 value of 0.236, which is categorized as very low. This indicates that only 23.6% of system usage behavior can be explained by System Quality, Information Quality, and Service Quality, while the remaining 76.4% is influenced by other factors not included in this model

b. Predictive Relevance (Q-Square)Q^2

The predictive relevance test aims to determine how well the constructs in the model can predict the endogenous constructs. The Q^2 value (Stone–Geisser's Q-square) is obtained through the blindfolding technique. Q^2 reflects how effectively the model represents the observed data.

The criteria for interpreting Q^2 values according to Sarstedt et al. (2021) are as follows: $Q^2 > 0$ The model has Predictive Relevance; $Q^2 = 0$ or $Q^2 < 0$ No Predictive Relevance. Predictive relevance strength **:** $Q^2 \geq 0.35$ Strong Prediction; $Q^2 \geq 0.15$ – < 0.35 Moderate Prediction; $Q^2 \geq 0.02$ – < 0.15 Weak Prediction

Tabel 7. Predictive Relevance Test Results

Variable	Q Square	Category
Use (Z1)	0.121	Weak
Net Benefit (Y)	0.465	Strong
User Satisfaction (Z2)	0.406	Moderate

Table 7 shows that the Use (Z1) construct has a Q^2 value of 0.121, categorized as weak. This suggests that the exogenous constructs have limited predictive power regarding system usage. The Net Benefit (Y) construct has a Q^2 value of 0.465, which is in the strong category, indicating that the model effectively predicts the perceived net benefits of using the e-learning system. Meanwhile, the User Satisfaction (Z2) construct has a Q^2 value of 0.406, categorized as moderate, meaning that the model can appropriately predict user satisfaction based on System Quality, Information Quality, and Service Quality.

Overall, these predictive relevance results indicate that the model has a good predictive capability, particularly for the constructs of net benefit and user satisfaction, making it suitable as a basis for developing more responsive e-learning systems.

c. Goodness of Fit (GoF)

The Goodness of Fit (GoF) test evaluates how well both the measurement model (outer model) and structural model (inner model) fit the data. In the Partial Least Squares (PLS) approach, model fit can be assessed using the Normed Fit Index (NFI). According to Narimawati & Sarwono (2022) : NFI close to 1 Good Model Fit; NFI far below 1 Poor Model Fit. NFI is calculated based on a comparison between the proposed model and a null model. The higher the NFI value, the better the model fits the data. The NFI value obtained in this study is shown in Table 8.

Table 8. NFI Value

Model	Saturated Model
NFI	0.750

Table 8 shows that the Normed Fit Index (NFI) obtained from the Saturated Model is 0.750**,** indicating a model fit level of 75.0%**.** Therefore, it can be concluded that the structural model used in this study has a reasonably good level of fit and is appropriate for testing the relationships between the variables.

d. Hypothesis Testing (*Bootstrapping*)

To evaluate the strength of relationships between variables in the model, hypothesis testing was conducted. This test aims to measure the magnitude of influence between variables using two types of analyses : direct effects and indirect effects**.** Direct effects measure the relationship between variables without involving mediator variables. Indirect effects examine the influence of independent variables on dependent variables through mediator variables.

Both types of effects were analyzed using path coefficients, t-statistics, and p-values obtained through the bootstrapping method. The significance criteria used were p-value < 0.1 and t-statistic > 1.645. The results determine whether each hypothesis is accepted or rejected. The hypothesis testing results based on the conceptual model are presented in Table 9. Path Coefficients**.**

Table 9. Path Coefficients

Path Coefficient	**T Statistics**	**P Values**
Information Quality (X2) -> Use (Z1)	4.023	0.000
Information Quality (X2)-> User Satisfaction (Z2)	4.733	0.000
Service Quality (X3)-> Use (Z1)	2.759	0.006
Service Quality (X3)-> User Satisfaction (Z2)	4.468	0.000
Sistem Quality (X1) -> Use (Z1)	0.905	0.366
Sistem Quality (X1) -> User Satisfaction (Z2)	1.781	0.076
Use (Z1) -> Net Benefit (Y)	5.502	0.000
User Satisfaction (Z) -> Net Benefit (Y)	10.677	0.000

Table 9 presents the results of the hypothesis testing as follows:

1) H_0: System Quality does not have a significant effect on Use.
   H_1: System Quality has a significant effect on Use. The obtained t-statistic value is 0.956 < 1.645 and the p-value is 0.339 > 0.1; therefore, H_1 is rejected and H_0 is accepted. This means that System Quality does not have a significant effect on Use.
2) H_0: System Quality does not have a significant effect on User Satisfaction. H_2: System Quality has a significant effect on User Satisfaction. The obtained t-statistic value is 1.781 > 1.645 and the p-value is 0.076 < 0.1; therefore, H_2 is accepted and H_0 is rejected. This indicates that System Quality has a significant effect on User Satisfaction.
3) H_0: Information Quality does not have a significant effect on Use. H_4: Information Quality has a significant effect on User Satisfaction. H0: Information Quality does not have a significant effect on User Satisfaction. The obtained t-statistic value is 4.733 > 1.645 and the p-value is 0.000 < 0.1; therefore, H_4 is accepted and H_0 is rejected. This indicates that Information Quality has a significant effect on User Satisfaction.
4) H_0: Service Quality does not have a significant effect on Use. H_5: Service Quality has a significant effect on Use. The obtained t-statistic value is 2.759 > 1.645 and the p-value is 0.006 < 0.1; therefore, H_5 is accepted and H_0 is rejected. This indicates that Service Quality has a significant effect on Use.
5) H_0: Service Quality does not have a significant effect on User Satisfaction.
   H_6: Service Quality has a significant effect on User Satisfaction. The obtained t-statistic value is 4.468 > 1.645 and the p-value is 0.000 < 0.1; therefore, H_6 is accepted and H_0 is rejected. This indicates that Service Quality has a significant effect on User Satisfaction.
6) H_0: Use does not have a significant effect on Net Benefit. H_7: Use has a significant effect on Net Benefit. The obtained t-statistic value is 5.502 > 1.645 and the p-value is 0.000 < 0.1; therefore, H_7 is accepted and H_0 is rejected. This indicates that Use has a significant effect on system success (Net Benefit).
7) H_0: User Satisfaction does not have a significant effect on Net Benefit. H_8: User Satisfaction has a significant effect on Net Benefit. The obtained t-statistic value is 10.677 > 1.645 and the p-value is 0.000 < 0.1; therefore, H_8 is accepted and H_0 is rejected. This indicates that User Satisfaction has a significant effect on system success (Net Benefit).

In addition to examining the direct effects among the main variables, this study also analyzes indirect effects to evaluate the mediating roles of intervening variables. The results of the indirect effect analysis are presented in Table 10.

Table 10. Indirect Effect Hypothesis Testing Results

Path Coefficient	T Statistics	P Values
Information Quality (X2) -> *Use* (Z1) -> *Net Benefit* (Y)	3.071	0.002
Service Quality (X3) -> *Use* (Z1) -> *Net Benefit* (Y)	2.504	0.013
Sistem Quality (X1) -> *Use* (Z1) -> *Net Benefit* (Y)	0.896	0.371
Information Quality (X2) -> *User Satisfaction* (Z2) -> *Net Benefit* (Y)	4.096	0.000
Service Quality (X3) -> *User Satisfaction* (Z2) -> *Net Benefit* (Y)	4.223	0.000
Sistem Quality (X1) -> *User Satisfaction* (Z2) -> *Net Benefit* (Y)	1.759	0.079

Based on the results presented in Table 10, the indirect effect hypothesis testing can be interpreted as follows:

1) Information Quality (X2) → Use (Z1) → Net Benefit (Y)
   The obtained t-statistic value is 3.071 > 1.645 and the p-value is 0.002 < 0.1, indicating that this path is significant. This means that Information Quality has a significant effect on Net Benefit through Use.
2) Service Quality (X3) → Use (Z1) → Net Benefit (Y)
   The obtained t-statistic value is 2.504 > 1.645 and the p-value is 0.013 < 0.1, indicating that this path is significant. This means that Service Quality has a significant effect on Net Benefit through Use.
3) System Quality (X1) → Use (Z1) → Net Benefit (Y)
   The obtained t-statistic value is 0.896 < 1.645 and the p-value is 0.371 > 0.1, indicating that this path is not significant. This means that System Quality does not have a significant effect on Net Benefit through Use.
4) Information Quality (X2) → User Satisfaction (Z2) → Net Benefit (Y)
   The obtained t-statistic value is 4.096 > 1.645 and the p-value is 0.000 < 0.1, indicating that this path is significant. This means that Information Quality has a significant effect on Net Benefit through User Satisfaction.
5) Service Quality (X3) → User Satisfaction (Z2) → Net Benefit (Y)
   The obtained t-statistic value is 4.223 > 1.645 and the p-value is 0.000 < 0.1, indicating that this path is significant. This means that Service Quality has a significant effect on Net Benefit through User Satisfaction.
6) System Quality (X1) → User Satisfaction (Z2) → Net Benefit (Y)
   The obtained t-statistic value is 1.759 > 1.645 and the p-value is 0.079 < 0.1, indicating that this path is significant. This means that System Quality has a significant effect on Net Benefit through User Satisfaction.

Conclusion

Based on the resul ts of the study on the success of the e-learning system at SMA Negeri 1 Kroya using the DeLone and McLean model, it can be concluded that this model is effective in explaining the factors influencing e-learning success. The R-square values indicate that system use, user satisfaction, and net benefits are significantly explained by system quality, information quality, and service quality, with relatively strong explanatory power. The hypothesis testing results show that most relationships among variables are significant, where information quality and service quality influence system use, system quality and information quality affect user satisfaction, and both system use and user satisfaction have a significant impact on net benefits. However, system quality does not significantly affect system use, and service quality does not significantly affect user satisfaction. Furthermore, the indirect effect analysis highlights that user satisfaction plays a more dominant mediating role than system use in generating net benefits, indicating that e-learning success is driven more by user experience and satisfaction than by usage intensity alone.

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