Enhancing Sustainable Service Quality Based on QR-Codes: A Case Study at The Archives Unit of Universitas Negeri Semarang

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Abstract

Digital transformation has emerged as a primary catalyst in promoting economic, environmental, and social sustainability. One potential form of digital innovation is the use of Quick Response Codes (QR-Code) in institutional services, including in the field of archives. The objective of this study is to analyze the effect of QR-Code utilization on the quality of sustainable services at the Archives Unit of Universitas Negeri Semarang. The research method utilizes a quantitative approach with Partial Least Squares (SmartPLS) analysis techniques. The findings indicate that attitude exerts a substantial influence on intention to use, and intention to use, in turn, demonstrates a notable impact on QR-code utilization. Furthermore, the variables Perceived Information Quality, Perceived System Quality, and Perceived Usefulness have been demonstrated to exert a significant influence on the formation of attitudes and usage intentions. Conversely, Perceived Ease of Use and Perceived Interactivity exhibit no substantial impact on attitudes or QR-Code utilization. A notable finding is that the implementation of QR codes has a positive effect on sustainable service quality, as evidenced by improvements in time efficiency, cost savings, and paper reduction. This study corroborates the notion that the integration of QR codes can serve as a digital service innovation strategy, thereby facilitating the realization of sustainable development goals within the higher education sector.

INTRODUCTION

Digitalization has become one of the main drivers in supporting economic, environmental, and social sustainability (Wang et al., 2023). Added by de Antônio et al. (2023) and De La Calle et al. (2021), the development of digitalization has accelerated efficiency and influenced all aspects of society through the provision of more inclusive, intelligent, and environmentally friendly services. Findings from Lin et al. (2024) revealed that digital transformation contributes to increased energy efficiency and reduced carbon emissions, which are among the challenges of sustainable development. Other studies have added that digital services can significantly reduce greenhouse gas emissions by up to 0.58 tons per household per year (Feroz et al., 2021; Heinz et al., 2023; Mohamed Hashim et al., 2022). To that end, appropriate digital innovation is a prerequisite for achieving sustainability goals in various organizations and institutions. In other words, service innovation supported by digital technology can help develop sustainable service quality.

One model for improving sustainable service quality is the use of Quick Response Codes (QR codes). This menu not only reduces paper waste but also offers benefits such as easier updates, clear images, and improved information quality. Therefore, the use of QR codes contributes to environmentally friendly practices that support sustainable development goals. Several studies explain that the application of QR codes can improve service quality, as it is more efficient and faster in updating information. (Yiğitoğlu et al., 2025). Similar to Ozturkcan & Kitapci (2023), the adoption of QR codes by universities can contribute to a more sustainable future by reducing carbon footprints and promoting environmentally friendly practices. In addition, Lerner et al. (2015)emphasize that QR codes are utilized in academic and commercial settings to connect customers with information on products, promotional services, sales, and communication.

Previous studies have also found that QR-Code menus can track inventory and product labelling in manufacturing, manage ticket activities in transportation, distribute instructions and various information, assist with document applications, and simplify office activities (Ardani & Harianto, 2023; Bala Krishna & Dugar, 2016; Del Rosario-Raymundo, 2017; KILIÇ et al., 2023). Thus, the use of QR codes in services has added value for an organization. At the Archives Unit of Universitas Negeri Semarang, the use of QR codes with the help of smartphones as code scanners is very easy to use for tracking documents or archives, making it easier for employees and users to identify the information they need. This information enables users to understand its content clearly. In addition, QR codes enable archivists to serve users quickly and accurately (Ardani & Harianto, 2023; Berndt-Morris & Chrenka, 2014). Another advantage of using QR codes for institutions is improved service quality and cost efficiency (Ardani & Harianto, 2023; Bala Krishna & Dugar, 2016; KILIÇ et al., 2023).

Several sustainability benefits related to QR codes are discussed in the study. First, the use of print media requires a significant amount of paper, which can contribute to environmental problems such as deforestation and pollution. By implementing QR codes, higher education institutions can significantly reduce paper usage, thereby contributing to a more sustainable environment. Second, the use of QR codes is more economical because they can be easily updated. Third, QR codes can increase the efficiency of time and costs required to track archives. Archivists can access QR codes with smartphones, saving energy in the process of searching and tracking archives. Fourth, QR codes are more flexible because they can be easily changed and items added if there are errors or missing information. Fifth, QR codes can enhance service quality by providing users with more detailed, fast, and accurate information, which in turn helps them make better decisions and increases overall user satisfaction. In addition, the use of QR codes can reduce user waiting times and improve service quality (Ashford, 2010; Gao et al., 2018; Koay & Ang, 2024).

Sustainable service quality remains a topic of debate among policymakers due to pressing challenges (Ali et al., 2021; Stamenkov & Dika, 2015). As shown in the examples above, digital innovation has been successful in helping to realize sustainable development. Evidenced by Saviano et al. (2017), designing and implementing digital service innovations can have a significant impact on sustainable change. Therefore, it

is important for service research in the discipline of information systems and technology to contribute to this research. However, there is still no comprehensive understanding of the relationship between digital service innovation, namely QR codes, and sustainable service quality. In fact, services and digitalization are global trends (Vendrell-Herrero et al., 2017), recent research highlights digital services (Kohtamäki & Rajala, 2016; Paschou et al., 2020; Sklyar et al., 2019). In line with Hossain et al. (2018), the use of QR codes has skyrocketed, but there has been no research that can provide a clear impact of QR codes on customer satisfaction and service quality, which is an important aspect of this study. From an information systems perspective, the use of digital technology can create new services or improve existing services (Heinz et al., 2023). Therefore, this study explores how the use of QR codes can improve the quality of sustainable services at the Archives Unit of Universitas Negeri Semarang.

METHODS

This study used a quantitative approach and purposive sampling. A closed questionnaire was used to record responses, which were divided into two main sections: demographic information and questions related to the research variables. The questionnaire was distributed via social media such as WhatsApp and Telegram. Respondents were invited to answer the questionnaire via an online link. Data was collected over a period of three months, from March to May. This study aimed to collect at least 57 responses. With 30 respondents answering the questionnaire, the response rate was 52.63%. The researchers suggested that studies with a response rate of 50% or above are suitable for further data analysis (Creswell & Plano Clark, 2018).

To measure the research variables, the scale used for the QR-Code utilization variable was usefulness, acceptability, and feasibility (Hossain et al., 2018). Meanwhile, the Sustainable Service Quality variable adopted indicators from Ozdemir et al. (2020), which consisted of five dimensions, namely Service to User, Physical Means, Responsiveness, Natural Sources, and Environmental Sensitivity. All items were assessed on a five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; and 5 = strongly agree). The adapted items were modified according to the research objectives.

This study collected data through an online survey, after filtering out invalid respondents, which was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Both approaches, Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM), were used to test the appropriate model. The CFA approach was used to test the validity and convergent reliability of the construct; thus, items with a value of less than 0.5 were eliminated from the construct (Hair et al., 2019). PLS-SEM is used in several disciplines, such as social sciences (Ahmed et al., 2020) and psychology (Rönkkö et al., 2015). The main reasons behind PLS-SEM include its popularity and wide acceptance.

RESULTS AND DISCUSSION

The data in this study consisted of 30 respondents collected through the distribution of online questionnaires to all archivists, officials of each designated unit, and educational staff of each designated unit in each faculty work unit at Universitas Negeri Semarang, which were included in the research criteria.

Table 1. Respondent Data

Criteria	Number	Percentage (%)
Gender		
Female	13	56.7%
Male	17	43.3%
Age		
19 – 25 year old	0	0%
26 – 35 year old	2	6.7%
36 – 45 year old	13	43.3%
46 – 55 year old	12	40%

Criteria	Number	Percentage (%)
> 56-year-old	3	10%
Income		
< Rp 2.500.000,00	0	0%
Rp 2.500.000,00 – Rp 3.500.000,00	7	23.3%
Rp 3.500.000,00 – Rp 4.500.000,00	7	23.3%
Rp 4.500.000,00 – Rp 5.500.000,00	8	26.7%
> Rp 5.500.000,00	8	26.7%
Education		
DIII	5	16.7%
DIV/S1	16	53.3%
S2	9	30%

Table 1 shows that the characteristics of the respondents in this study indicate a fairly diverse composition. In terms of gender, the majority of respondents were female, numbering 13 people (56.7%), while males numbered 17 people (43.3%), indicating a relatively balanced involvement between the two genders, although female participation was slightly higher.

In terms of age, the respondents were dominated by the middle productive age group, namely 13 people (43.3%) aged 36–45 years and 12 people (40%) aged 46–55 years. Meanwhile, the 26–35 age group accounted for only two people (6.7%), and those aged above 56 numbered three people (10%). There were no respondents in the 19–25 age group, indicating that the participants came from an age segment with more mature work experience.

When viewed from the income level, the distribution of respondents was relatively even in the middle range. A total of 7 people (23.3%) had an income between IDR 2,500,000.00 and IDR 3,500,000.00, with the same number found in the IDR 3,500,000.00–IDR 4,500,000.00 category. Meanwhile, eight respondents (26.7%) had incomes ranging from IDR 4,500,000.00 to IDR 5,500,000.00, with one respondent having an income above IDR 5,500,000.00. There were no respondents with an income below Rp 2,500,000.00, indicating that the respondents' welfare level tended to be quite good.

In terms of education level, most respondents had a DIV/S1 background, totaling 16 people (53.3%), followed by nine people (30%) with an S2 degree, and five people (16.7%) with a D3 degree, illustrates that the majority of respondents had a high level of education, which could potentially influence their mindset and responses to the research variables.

Validity Test

The validity test aims to ensure that the research instrument used is truly capable of measuring what it is supposed to measure. This test compares the calculated r value with the table r value, considering an item valid if the calculated r value is positive and greater than or equal to the table r value. Conversely, if the value is lower than the r-table, then the item is considered invalid. Based on the results of the instrument testing, the data is presented as follows.

Table 2. Instrument Validity Test Results

Variables	Item	r count	r table	a	Decision
Perceived information quality	PIQ1	0.659**	0.361	0.000	Valid
	PIQ2	0.847**	0.361	0.000	Valid
	PIQ3	0.803**	0.361	0.000	Valid
Perceived system quality	PSQ1	0.625**	0.361	0.000	Valid
	PSQ2	0.822**	0.361	0.000	Valid
	PSQ3	0.761**	0.361	0.000	Valid
Perceived interactivity	PI1	0.746**	0.361	0.000	Valid
	PI2	0.743**	0.361	0.000	Valid
	PI3	0.667**	0.361	0.000	Valid
Perceived usefulness	PU1	0.770**	0.361	0.000	Valid
	PU2	0.649**	0.361	0.000	Valid

Variables	Item	r count	r table	*a*	Decision
	PU3	0.721**	0.361	0.000	Valid
PEoU	PEoU1	0.499**	0.361	0.000	Valid
	PEoU2	0.742**	0.361	0.000	Valid
	PEoU3	0.666**	0.361	0.000	Valid
SN	SN1	0.522**	0.361	0.003	Valid
	SN2	0.392*	0.361	0.032	Valid
Attitude	A1	0.588**	0.361	0.001	Valid
	A2	0.576**	0.361	0.001	Valid
	A3	0.881**	0.361	0.000	Valid
	A4	0.863**	0.361	0.000	Valid
Intention to Use	IU1	0.781**	0.361	0.000	Valid
	IU2	0.870**	0.361	0.000	Valid
	IU3	0.798**	0.361	0.000	Valid
QR-Code	QR1	0.892**	0.361	0.000	Valid
	QR2	0.879**	0.361	0.000	Valid
	QR3	0.733**	0.361	0.000	Valid
	QR4	0.878**	0.361	0.000	Valid
	QR5	0.798**	0.361	0.000	Valid
	QR6	0.636**	0.361	0.000	Valid
Sustainable Service Quality	SQ1	0.919**	0.361	0.000	Valid
	SQ2	0.918**	0.361	0.000	Valid
	SQ3	0.941**	0.361	0.000	Valid
	SQ4	0.832**	0.361	0.000	Valid

Of the 31 items tested for validity, all items were declared valid because they met the criteria where the calculated r value was greater than the table r value, or the significance value was less than 0.05. Thus, all items in this study are valid.

Reliability Test

A reliability test was conducted to assess the consistency level of the research instruments used. This test refers to the Cronbach's Alpha value, where a variable is considered reliable if it has a Cronbach's Alpha value greater than 0.6.

Table 3. Reliability Test Results

Variables	*a*	Decision
Use of QR Codes	0.958	Reliable
Sustainable Service Quality	0.925	Reliable

Table 8 shows that the use of QR codes has an alpha value of 0.958, which is considered reliable. Similarly, the variable of sustainable service quality also has a value of more than 0.60, namely 0.925, which is considered reliable.

Normality Test

The normality test is used to determine whether the data is normally distributed. This test is carried out using the Kolmogorov-Smirnov method, with the provision that if the significance value is < 0.05, the data is declared not normally distributed. Conversely, if the significance value is > 0.05, the data is considered normally distributed.

Table 4. Normality Test Results

N		30
Normal Parameters [a,b]	Mean	135.87
	Std. Deviation	12.629
Most Extreme Differences	Absolute	0.160
	Positive	0.160
	Negative	-0.155
Test Statistic		0.160
Asymp. Sig. (2-tailed)		0.059[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Based on Table 4, a significance value of 0.059 was obtained, which is greater than 0.05. Thus, it can be concluded that the data on the QR code usage variable and the sustainable service quality variable are normally distributed.

Measurement Model (Outer Model)

This study uses data analysis techniques with SmartPLS, which, in its measurement model (outer model), includes three types of tests, namely convergent validity, discriminant validity, and composite reliability.

Convergent validity

The purpose of this measurement is to ensure the validity of the relationship between indicators and the constructs or latent variables they represent. According to Wiyono (2011), an indicator is considered valid if it has a loading factor value of more than 0.50; a value between 0.50 and 0.60 can still be considered adequate for the construct being measured. In addition, convergent validity can also be evaluated through the Average Variance Extracted (AVE) value. According to Hair et al. (2014), a measurement model is considered good if the latent construct has an AVE value of more than 0.50. Based on the number of indicators used to measure each variable, the PLS (Partial Least Squares) model estimated in this study can be described as follows:

Table 5. Convergent Validity Results

Variables	Item	*Loading*	CR	*a*	AVE
Perceived information quality	PIQ1	0.794	0.987	0.906	0.841
	PIQ2	0.973			
	PIQ3	0.972			
Perceived system quality	PSQ1	0.842	0.843	0.825	0.739
	PSQ2	0.889			
	PSQ3	0.846			
Perceived interactivity	PI1	0.806	0.768	0.762	0.679
	PI2	0.889			
	PI3	0.773			
Perceived usefulness	PU1	0.875	0.856	0.854	0.775
	PU2	0.865			
	PU3	0.900			
PEoU	PEoU1	0.785	0.834	0.803	0.716
	PEoU2	0.899			
	PEoU3	0.850			
SN	SN1	0.969	0.964	0.909	0.915
	SN2	0.944			

Variables	Item	*Loading*	CR	*a*	AVE
Attitude	A1	0.772	0.879	0.836	0.668
	A2	0.732			
	A3	0.891			
	A4	0.864			
Intention to Use	IU1	0.887	0.873	0.865	0.787
	IU2	0.887			
	IU3	0.887			
QR-Code	QR1	0.926	0.939	0.929	0.743
	QR2	0.893			
	QR3	0.830			
	QR4	0.891			
	QR5	0.904			
	QR6	0.711			
Sustainable Service Quality	SQ1	0.884	0.962	0.924	0.810
	SQ2	0.887			
	SQ3	0.955			
	SQ4	0.873			

Based on Table 5 and the figure below, each indicator has a loading factor value > 0.50. Thus, all constructs in each variable are declared valid and suitable for further analysis. After ensuring that convergent validity is met, the next step is to test the reliability of the constructs. Reliability testing is conducted to ensure that the indicators used consistently measure the same variable. This reliability can be assessed through the Composite Reliability (CR) and Cronbach's Alpha values. According to Hair et al. (2019), a construct is considered reliable if it has a CR value > 0.70, a Cronbach's Alpha value > 0.60, and an AVE > 0.5, so that the construct can be said to be valid.
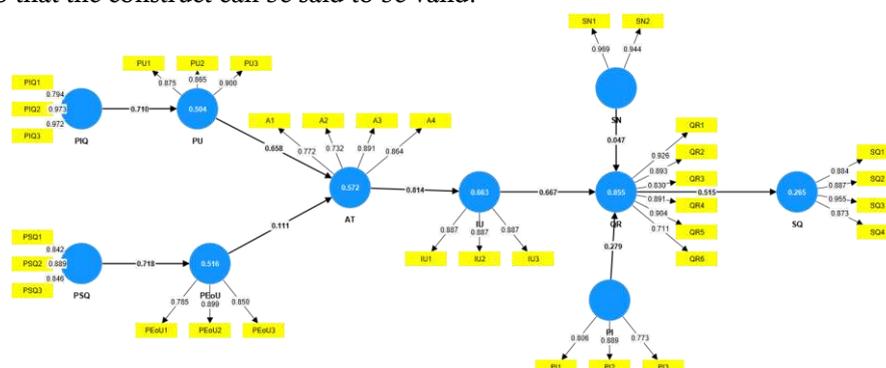

Figure 1. SmartPLS 4 program output, 2025

Discriminant validity

Discriminant validity is used to ensure that each construct measured is genuinely different from other constructs in the model. A model is said to have good discriminant validity if the loading value of each indicator is greater on the construct it measures than on other constructs (Cheung et al., 2024). The results of the discriminant validity test in this study are shown in the following table:

Table 6. Discriminant Validity Results (Fornell-Larcker Criterion)

	AT	IU	PEoU	PI	PIQ	PSQ	PU	QR	SN	SQ
AT	0.817									
IU	0.814	0.887								
PEoU	0.678	0.770	0.846							
PI	0.834	0.806	0.555	0.824						

	AT	IU	PEoU	PI	PIQ	PSQ	PU	QR	SN	SQ
PIQ	0.670	0.783	0.611	0.678	0.917					
PSQ	0.783	0.764	0.718	0.735	0.847	0.859				
PU	0.754	0.759	0.862	0.563	0.710	0.679	0.880			
QR	0.858	0.907	0.652	0.835	0.786	0.781	0.747	0.862		
SN	0.376	0.329	0.214	0.410	0.273	0.296	0.175	0.381	0.957	
SQ	0.377	0.525	0.460	0.415	0.458	0.314	0.549	0.515	0.069	0.900

Based on the results of the Discriminant Validity test using the Fornell-Larcker criteria, it can be seen that each construct has a larger AVE square root value (diagonal number) than the correlation with other constructs. For example, the AT construct has a value of 0.817, which is higher than its highest correlation with other constructs (0.854 with QR). Similarly, the IU, PEoU, PI, PIQ, PSQ, PU, QR, SN, and SQ constructs exhibit a similar pattern, indicating that each construct can distinguish itself from the others.

However, there are some fairly high correlations, such as between IU and QR (0.907) or AT and QR (0.854), which indicate a close relationship between these variables. However, these relationships are still below the square root of the AVE value of each construct, so they still meet the criteria for discriminant validity. In addition, the SN construct exhibits the lowest correlation with other variables, as evidenced by a correlation coefficient of only 0.218 with PeoU, indicating that SN is relatively independent and not too closely related to other constructs. Overall, these results confirm that the research model has good discriminant validity, where each latent variable can be clearly distinguished from the others, even though there are groups of variables with fairly strong relationships.

Table 7. Cross Loading Results

	AT	IU	PEoU	PI	PIQ	PSQ	PU	QR	SN	SQ
A1	0.772	0.412	0.419	0.499	0.415	0.581	0.555	0.556	0.147	0.118
A2	0.732	0.546	0.424	0.610	0.337	0.389	0.405	0.472	0.278	0.271
A3	0.891	0.788	0.655	0.843	0.657	0.703	0.794	0.857	0.360	0.449
A4	0.864	0.811	0.648	0.708	0.683	0.807	0.634	0.814	0.389	0.321
IU1	0.605	0.887	0.665	0.639	0.801	0.665	0.660	0.774	0.233	0.491
IU2	0.843	0.887	0.642	0.873	0.635	0.682	0.641	0.853	0.397	0.434
IU3	0.694	0.887	0.748	0.603	0.663	0.686	0.723	0.777	0.226	0.478
PEoU1	0.400	0.498	0.785	0.312	0.491	0.537	0.565	0.381	0.132	0.289
PEoU2	0.731	0.680	0.899	0.624	0.496	0.661	0.798	0.640	0.246	0.426
PEoU3	0.540	0.756	0.850	0.421	0.576	0.615	0.796	0.597	0.146	0.435
PI1	0.732	0.604	0.593	0.806	0.635	0.781	0.507	0.654	0.364	0.215
PI2	0.645	0.723	0.353	0.889	0.618	0.641	0.330	0.740	0.427	0.334
PI3	0.694	0.660	0.441	0.773	0.420	0.397	0.572	0.667	0.214	0.477
PIQ1	0.525	0.617	0.478	0.545	0.794	0.730	0.412	0.592	0.251	0.329
PIQ2	0.678	0.777	0.637	0.656	0.973	0.806	0.782	0.800	0.263	0.511
PIQ3	0.626	0.747	0.551	0.659	0.972	0.809	0.677	0.743	0.249	0.390
PSQ1	0.522	0.527	0.481	0.488	0.728	0.842	0.479	0.574	0.154	0.253
PSQ2	0.759	0.675	0.683	0.713	0.770	0.889	0.718	0.770	0.259	0.375
PSQ3	0.698	0.737	0.652	0.656	0.688	0.846	0.525	0.642	0.325	0.173
PU1	0.754	0.791	0.762	0.569	0.517	0.524	0.875	0.793	0.207	0.568
PU2	0.560	0.603	0.777	0.371	0.685	0.586	0.865	0.552	0.115	0.498
PU3	0.674	0.611	0.739	0.541	0.672	0.680	0.900	0.627	0.141	0.389

	AT	IU	PEoU	PI	PIQ	PSQ	PU	QR	SN	SQ
QR1	0.871	0.834	0.574	0.841	0.736	0.729	0.715	0.926	0.359	0.440
QR2	0.782	0.822	0.699	0.699	0.796	0.768	0.856	0.893	0.282	0.524
QR3	0.597	0.660	0.353	0.718	0.718	0.675	0.434	0.830	0.380	0.381
QR4	0.849	0.866	0.566	0.860	0.683	0.688	0.627	0.891	0.389	0.453
QR5	0.754	0.788	0.608	0.690	0.572	0.571	0.670	0.904	0.329	0.520
QR6	0.526	0.699	0.556	0.461	0.555	0.606	0.515	0.711	0.220	0.320
SN1	0.358	0.376	0.314	0.415	0.357	0.358	0.262	0.408	0.969	0.122
SN2	0.363	0.234	0.059	0.363	0.135	0.185	0.043	0.307	0.944	-0.007
SQ1	0.203	0.323	0.345	0.218	0.433	0.251	0.469	0.305	-0.045	0.884
SQ2	0.188	0.369	0.408	0.191	0.391	0.297	0.480	0.378	-0.064	0.887
SQ3	0.361	0.535	0.461	0.440	0.408	0.289	0.564	0.542	0.098	0.955
SQ4	0.505	0.571	0.415	0.527	0.425	0.286	0.453	0.539	0.176	0.873

The Cross Loading results show that all indicators have the highest loading on the construct being measured, indicating consistency and clarity of measurement. Some indicators have relatively high correlations with other constructs, such as IU2 with PI (0.873) or A3 with QR (0.857), but these are still lower than the loadings on the primary construct. The SN and SQ constructs appear to be very consistent, with differences between loadings to their own constructs and to other constructs. Overall, no significant cross-loading problems were found, so the discriminant validity of the model can be considered fulfilled.

Inner Model

The inner model is used to evaluate the strength of the relationship between constructs in a structural model (Ghozali & Latan, 2015). The structural model evaluation is carried out by considering the R-Square value, which shows the amount of variance in endogenous constructs that can be explained by exogenous constructs, as well as the significance level of the relationship between variables (Hair, 2011).
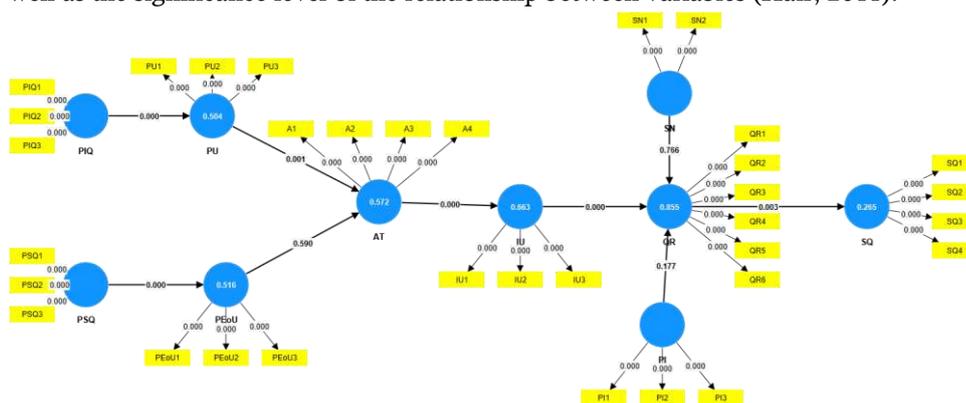

Figure 2. SmartPLS 4 program output, 2025

R-Square Results

The R-Square value is used to assess the extent to which independent latent variables can explain dependent latent variables, thereby determining the strength of their substantive influence. According to Ghozali & Latan (2015), an R-Square value of 0.75 indicates a strong model, 0.50 indicates a moderate model, and 0.25 indicates a weak model.

Table 8. R-Square Results

	R-square	R-square adjusted
SQ	0.265	0.239

The analysis results show that the SQ construct has the lowest R-Square value (0.265), indicating that only 26.5% of the variation can be explained by other constructs, so there are still factors outside the model that influence SQ. Overall, most constructs have good to extreme predictive power, in accordance with the general R-Square assessment criteria.

Goodness of Fit Test Results

The Goodness of Fit (GoF) results show that the SRMR value in the Saturated Model is 0.011 and in the Estimated Model is 0.089. These values are below the general threshold of 0.10, so it can be concluded that the model has a good level of fit with the data. The NFI value of 0.625 in both models indicates a moderate level of model fit. Overall, these results indicate that the structural model used is feasible and acceptable for further analysis.

Table 9. GoF Test Results

	Saturated Model	Estimated Model
SRMR	0.011	0.089
NFI	0.625	0.625

Hypothesis Test Results

The path coefficient value indicates the level of significance in hypothesis testing. In this study, hypothesis testing was conducted with a significance level (α) of 5%, where the reference t-statistic value was 1.96. Thus, the alternative hypothesis (Ha) was accepted and the null hypothesis (H_0) was rejected if the t-statistic > 1.96. In addition, significance can also be seen through the p-value. If the p-value is < 0.05, then the relationship between variables is considered significant; conversely, if the p-value is $\geq$ 0.05, the relationship is not significant (Ghozali & Latan, 2015).

Table 10. Hypothesis Test Results

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AT -> IU	0.814	0.824	0.052	15.594	0.000
IU -> QR	0.667	0.645	0.171	3.897	0.000
PEoU -> AT	0.111	0.116	0.206	0.538	0.590
PI -> QR	0.279	0.230	0.207	1.349	0.177
PIQ -> PU	0.710	0.734	0.096	7.406	0.000
PSQ -> PEoU	0.718	0.737	0.079	9.096	0.000
PU -> AT	0.658	0.660	0.201	3.275	0.001
QR -> SQ	0.515	0.546	0.173	2.979	0.003
SN -> QR	0.047	0.116	0.159	0.297	0.766

The path coefficient test results show that most of the relationships between constructs are significant at a significance level of 0.05. The strongest relationship is between AT $\rightarrow$ IU (β = 0.814; t = 15.594; p < 0.001), followed by PIQ $\rightarrow$ PU (β = 0.710; t = 7.406; p < 0.001) and PSQ $\rightarrow$ PEoU (β = 0.718; t = 9.096; p < 0.001). The relationship between PU $\rightarrow$ AT (β = 0.658; t = 3.275; p = 0.001), IU $\rightarrow$ QR (β = 0.667; t = 3.897; p < 0.001), and QR $\rightarrow$ SQ (β = 0.515; t = 2.979; p = 0.003) were also significant.

Conversely, several paths were not significant, namely PEoU → AT (p = 0.590), PI → QR (p = 0.177), and SN → QR (p = 0.766), which means that these variables did not have a direct statistical effect on these paths. Overall, the model shows that perceptions of information quality, service quality, and usefulness play an important role in shaping attitudes and intention to use, which ultimately have an impact on quality results (QR) and satisfaction (SQ).

DISCUSSION

The results of this study prove that the Attitude (AT) variable has a significant positive effect on Intention to Use (IU) with a path coefficient value of 0.814, t-statistic of 15.594, and p-value < 0.001, showing that the more positive the users' attitudes toward the technology offered, the greater their intention to use it. This finding is in line with the Theory of Planned Behavior (Ajzen, 2020), which asserts that attitude is the primary determinant of behavioral intention. Several previous studies support this result. Rahmawati & Narsa (2019) found that students' positive attitudes toward e-learning significantly increased their intention to use it. Park et al. (2024) also reported that positive perceptions of AI-based learning technology encourage the intention to use it in the higher education sector. Muhammad Daffa & Praswati (2023) proved that attitude mediates the relationship between perceived usefulness and the intention to use mobile applications. Other studies confirm that attitude has a significant contribution in the UTAUT model (Venkatesh et al., 2012). In the MSME sector, positive attitudes toward digital cashier systems are a major driving factor in intention to use (Husrizal Syah et al., 2022; Saripudin et al., 2023).

Furthermore, the relationship between Intention to Use (IU) and QR-Code (QR) utilization was also proven to be significant with a coefficient of 0.667 (t = 3.897; p < 0.001). This finding indicates that the higher the intention to use, the greater the chance that users will utilize QR-Codes as part of the service. These results are consistent with the Technology Acceptance Model, which places intention as a direct predictor of actual behavior (actual use) (Davis & Davis, 1989). Research by Pontoh et al. (2022) proves that intention to use has a significant influence on the implementation of QRIS in MSMEs. Jeong (2011) confirmed that behavioral intention is a dominant factor in the adoption of QR payment technology. Fadilah et al. (2024) found a similar relationship in digital transportation applications. Saleem et al. (2023) showed that intention to use mobile banking is a major predictor of actual use. Hossain et al. (2018) reinforced the evidence that intention directly influences the implementation of barcode and QR technology in modern transactions.

Unlike the previous two hypotheses, the relationship between Perceived Ease of Use (PEoU) and Attitude (AT) in this study was not significant (p = 0.590), indicating that perceived ease of use does not directly shape users' attitudes toward technology. This phenomenon can be explained by the fact that most respondents are already familiar with similar technologies, so ease of use is no longer a determining factor in attitude. Kolade & Owoseni (2022) also found that PEoU is not significant for attitude if users have previous technological experience. Toros et al. (2024) revealed that PEoU has a greater influence on perceived usefulness than on attitude. Kumar & Krishnan (2020) stated that the effect of PEoU on attitudes tends to weaken as users' technological literacy increases. Jang (2023) also reported similar results among users of digital health applications. Liao et al. (2022) emphasized that the influence of PEoU is more substantial in the early stages of adoption than in the later stages.

Meanwhile, the relationship between Perceived Interactivity (PI) and QR-Code (QR) usage was also insignificant (p = 0.177), indicating that the level of perceived interactivity does not directly encourage the use of QR-Codes. Kim et al. (2015) found that interactivity has a greater impact on user satisfaction and loyalty, rather than directly on usage behavior. Liu et al. (2022) stated that interactivity affects trust, which in turn encourages usage. Bao et al. (2016) showed that interactivity is only compelling when accompanied by relevant functional features. Jeon et al. (2017) also prove that the influence of interactivity is more dominant in the perception of service quality. Utomo et al. (2022) emphasize that interactivity requires the mediation of perceived usefulness in order to influence actual usage.

CONCLUSION

This study found that the use of QR codes at the Archives Unit of Universitas Negeri Semarang can contribute to improving the quality of sustainable services. The analysis shows that users' positive attitudes toward technology are a key factor that drives their intention to use QR codes, which ultimately has a significant effect on their implementation in archival services. These findings reinforce the perception that attitudes and intentions are determinants of technology acceptance, as explained in the Theory of Planned Behavior and Technology Acceptance Model.

In addition, this study reveals that perceptions of information quality, system quality, and usefulness play an important role in shaping attitudes and intentions to use digital technology. However, the ease of use factor was not proven to have a direct effect on attitudes, which was likely due to the users' already high level of digital literacy. Furthermore, the perception of interactivity was not proven to influence the use of QR codes directly, but was more relevant in influencing other aspects, such as user satisfaction or loyalty.

In this study, the use of QR codes had a positive effect on the creation of more efficient, environmentally friendly, and cost-effective services. The implementation of QR codes reduces dependence on print media, speeds up access to information, and facilitates the archiving process, thereby supporting the achievement of sustainable development goals in higher education. Thus, digital service innovation through QR codes can be an important strategy for educational institutions to improve service quality while responding to sustainability demands.

Based on these findings, this study recommends that educational institutions, especially archival service units, continue to develop QR-Code systems with consideration for data security, access speed, and integration with other information systems. Digital literacy for staff and users also needs to be strengthened through training and socialization so that the benefits of technology can be optimally realized. In addition, policy support from university leaders is needed to ensure the sustainability of this technology's implementation as part of the campus digital transformation strategy.

For further research, it is recommended that studies not only focus on the perceptions of internal users but also involve external stakeholders such as students, alumni, and partners. Further research could also expand the variables, for example, by examining the role of user satisfaction, digital loyalty, or organizational culture factors in strengthening the relationship between technology adoption and sustainable service quality. With this approach, it is hoped that a more comprehensive picture of the contribution of digital technology in driving sustainable public service transformation can be provided.

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