

Evaluating Adaptive Reuse Criteria for Malaysia's Pre-war Shophouses: A Correlation Analysis

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Abstract

Pre-war shophouses are among the historic structures that deserve preservation, including adaptive reuse. The preservation of old and historic buildings is thought to be possible through the implementation of adaptive reuse. However, choosing between adaptive reuse and other options is difficult because many factors need to be considered. Therefore, the adaptive reuse criteria must be considered before selecting a potential adaptive reuse. There are six broad parameters of adaptive reuse criteria: Economy, Social, Legislative, Technology, Architecture, and Environment. 123 pilot survey was conducted on heritage experts such as each state's local authorities (town planners), architects' firms, and the Valuation and Property Service Department (JPPH). Thirty-three criteria were found in a heritage building in Malaysia. SPSS is used to analyze these criteria to determine the significance level of each criterion in Malaysia's heritage buildings. It helps the key parties decide to reuse the prewar shophouse rather than demolish it and replace it with new structures. This conversion of existing building structures is environmentally sustainable because it entails reusing resources while retaining the morphological structure of urban areas. Additionally, the results show that all the variables (criteria) have a strong correlation with each other. This strong correlation suggests that these criteria work together as a comprehensive framework for making informed preservation choices. This reinforces the value of maintaining heritage buildings over replacing them with new constructions, preserving both cultural and environmental heritage.

1. Introduction

Malaysia is a developing country with many historical settlements, and these structures hold cultural significance. Depending on climatic conditions and building typology, different country regions develop buildings and complexes with their style and character. Many historic town centers, particularly in Kuala Terengganu, Alor Setar, Kota Bharu, and Batu Pahat, feature pre-war era storehouses. These structures represent significant components

of the heritage building inventory, but they are currently at risk of demolition and in poor condition. Analysis of previous case studies has revealed five distinct architectural styles: Early Shop House, Early Transitional Shop House, Strait Eclectic Shop House, Art Deco Shop House, and Modern Style Shop House. Figure 1 shows the types of pre-war shophouses in Malaysia (Tan & Fujita, 2014).

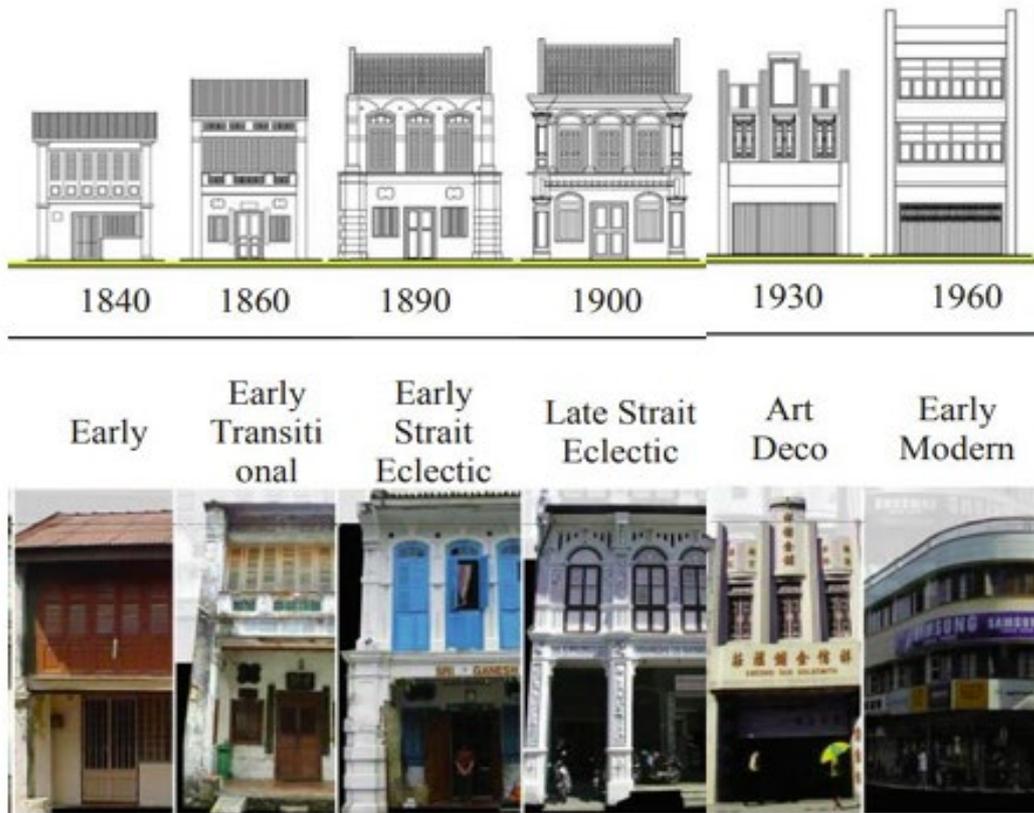


Fig. 1 Types of pre-war shophouses in Malaysia (Tan & Fujita, 2014)

Pre-war shophouses in Malaysia are sought to be restored, acquired, and hold historical or cultural importance. Local authorities, architects, and the Valuation and Property Service Department (JPPH) are key stakeholders in Malaysia who can influence decisions on the criteria for pre-war shophouses. Each expert has different thoughts, concerns, and judgments regarding the case. This study highlights the potential criteria of pre-war shophouses at a significant level by utilizing SPSS to evaluate the association between the pre-war shophouse criteria. This correlation analysis offers a more efficient assessment approach. The correlation test results will guide key parties in deciding to reuse the pre-war shophouses in Batu Pahat, Johor. Table 1 shows thirty-three criteria commonly found in the criteria of heritage buildings that were selected for this study (Mohd Abdullah, et al., 2020).

Table 1 Criteria for Adaptive Reuse Potential (Mohd Abdullah, et al., 2020)

No.	Criteria	No.	Criteria
1	Site amenities	18	Reduction of resource consumption
2	Client requirement	19	Environmental effect
3	Material and decorations	20	Scenic/ contextual value
4	Building character	21	Official plan and zoning regulation
5	Structural condition	22	Vacancy
6	Building services	23	Site Layout
7	Condition of integrity and authenticity	24	Neighborhood condition
8	Compatibility of new uses and existing	25	Reduce the use of greenfield
9	Local's perception	26	Building system

10	Regional development and policies	27	Potential market
11	Building code, regulation and heritage design requirements	28	Renovation and maintenance
12	Architectural and physical condition	29	Subsidize and benefit from exemption
13	Available facilities	30	Space gain and change
14	Building location	31	Financial and investment
15	Building suitability	32	Enhancing the role of communities
16	Retaining a sense of place	33	Social value
17	Building value		

Adaptive reuse involves repurposing buildings for new uses when their original function becomes obsolete or undesirable (Said et al., 2021). Even as outdated structures approach decommissioning or potential demolition, their fundamental framework remains intact and can be preserved or modified for alternative purposes (Firzan et al., 2022). Heritage values are used as a framework for discussing and designing adaptive reuse projects, encompassing both tangible and intangible aspects (Nadin et al., 2023). This transformation of existing building structures is environmentally sustainable, as it involves reusing materials, while maintaining the morphological structure of urban areas. This approach enhances our understanding of a location and boosts its historical significance (Remoy & Van der Voordt, 2007). In Johor, the Valuation and Property Service Management (JPPH) has recorded 2886 pre-war shophouse buildings. Muar had the highest count at 710, followed by Batu Pahat with 617 buildings, while there were no recorded pre-war shophouses in Mersing. The Figure 2 illustrates the distribution of pre-war buildings by district in Johor, as per the Commercial Property Stock Table for Q3 2023.

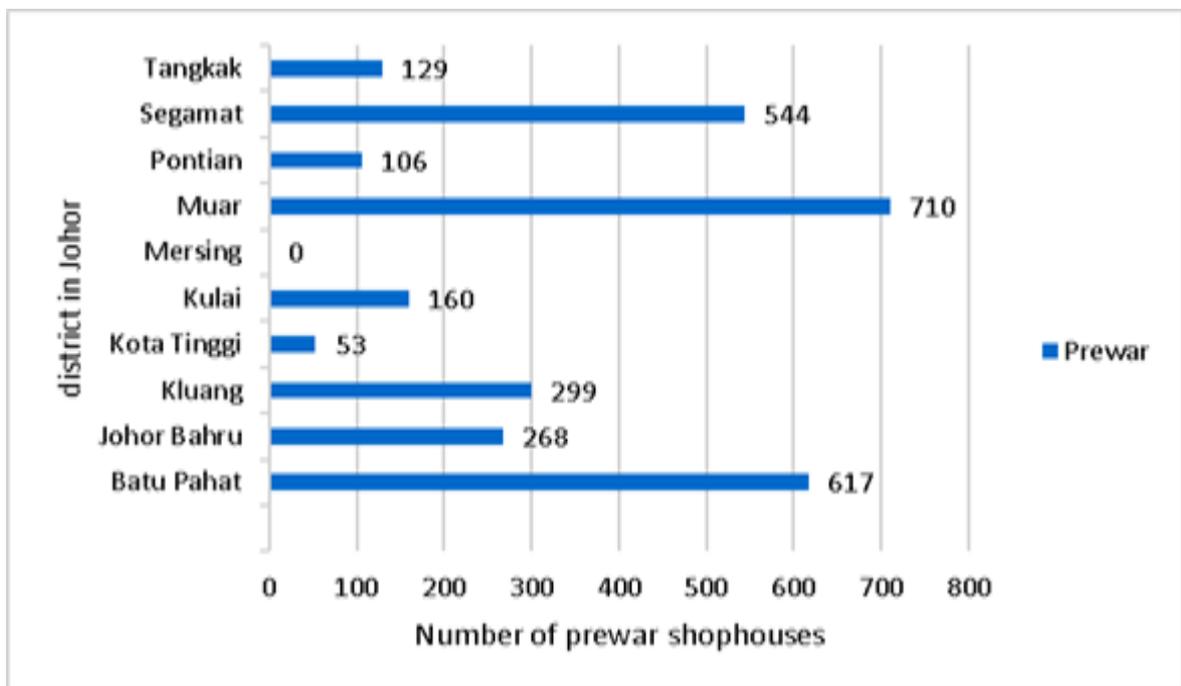


Fig. 2 Shop, SOHO, and serviced apartment types of commercial space available in Johor (Commercial Property Stock Table Q3, 2023)

Thirty-three criteria for adapting pre-war shophouses were studied based on existing research (Mohd Abdullah, et al., 2020). Additional criteria that could be considered, but the study focused only on these thirty-three criteria. Figure 3 shows the criteria classified under six broad parameters: Economic, Environmental, Social, Technological, Legislative, and Architectural (Mohamed & Alauddin, 2016).

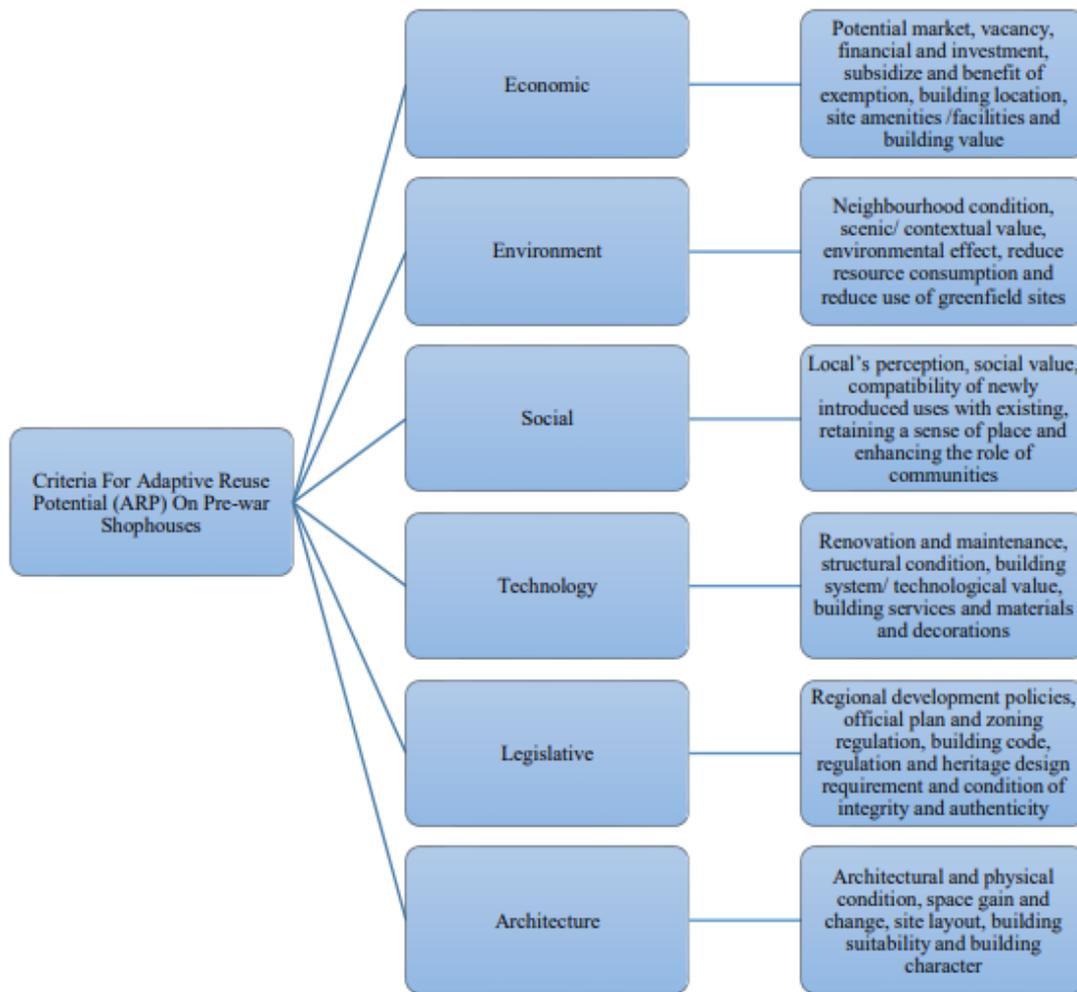


Fig. 3 The criteria related to adaptive reuse (Adapted from Mohamed & Alauddin, 2016)

A pilot survey was conducted on 123 professionals in the field of heritage building conservation to classify these criteria on a 1-5 scale. In this study, the correlation coefficient, *r*-value, is used to assess the correlation in a dataset explained by a statistical model. Based on the data from the experts, these criteria will be analyzed using SPSS, which offers correlation and significance levels among the variables examined. Despite extensive use of correlation analysis in heritage building assessments, there remains a gap in the development of a practical, streamlined framework that effectively utilizes these interdependent criteria to guide preservation decisions. Current studies often overlook the balance between environmental sustainability and cultural preservation in adaptive reuse, particularly for heritage structures such as Malaysia's pre-war shophouses. This study addresses these limitations by proposing a cohesive assessment framework aimed at preserving the historical and environmental value of these buildings. The results will guide key stakeholders in making informed decisions about repurposing existing pre-war shophouses in Batu Pahat, Johor.

2. Data Collection

This study uses a questionnaire as its primary data collection tool. The data was recorded and analyzed using SPSS software version 27. Correlation analysis, such as the coefficient of correlation and coefficient of determination, is used to identify the relationship between two variables. Hypothesis testing is implemented in this study to provide strong evidence to support the claim or statement.

2.1 Questionnaire

A survey instrument, a questionnaire, comprises a series of inquiries used in an investigation to collect, sample, analyze, and interpret data from a group. It serves as just one tool in the process of conducting a survey. The questionnaire formulation involves identifying criteria for decision-making and the potential for adaptive reuse,

which is informed by a review of existing literature and previous case studies (Mohamed et al., 2016). This questionnaire is administered to specific respondents, such as town planners from local authorities, panel members from the Valuation and Property Service Department (JPPH), and architects, to ensure the reliability of the collected data. The respondents' educational background and professional experiences also influence the decision-making process. To facilitate online surveys, the questionnaire forms will be distributed via email. According to Wynter et al. (2015), online surveys are appropriate for data collection due to their time and cost-control efficiency. The questionnaire consists of the respondents' background in Part 1 and The Likert scale for important criteria described in Part 2. The questionnaire aims to achieve research objectives. Lastly, a pilot study was conducted to ensure the questionnaire survey was in the appropriate format. A questionnaire was prepared and sent to 123 conservation professionals, asking them to rate 33 criteria selected from heritage buildings in Malaysia on a scale of 1 to 5, where 5 is the most significant and 1 is the least significant. All results have been filtered, recorded, and are ready for analysis.

2.2 Correlation Analysis

Correlation analysis fundamentally aims to quantify the strength of the association between two variables, namely the dependent variable (Y) and the independent variable (X), utilizing the coefficient of correlation (r), which provides insights into the type, direction, and magnitude of the relationship between these factors (Kumar and Gautam, 2020). To ascertain the strength of the connection between the independent and dependent variables, this can be expressed through the computation of the coefficient of correlation, denoted as r -value, utilizing the actual values of X and Y , as outlined below.

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X)^2][n(\sum Y^2) - (\sum Y)^2]}} \quad (1)$$

where

X independent variable

Y dependent variable

n number of samples (respondents)

Figure 4 summarises the strength and direction of the correlation coefficient, r .

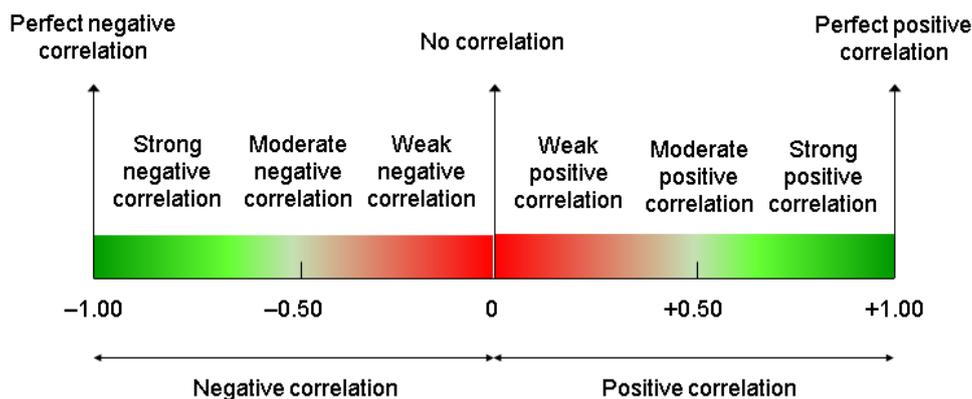


Fig. 4 Summary of the strength of the coefficient of correlation (Gogtay and Thatte, 2017)

The Figure 4 shows that if r is close to zero, the relationship is considered weak. When the correlation coefficient approaches 1.00, it indicates a solid or perfect correlation between the two variables. This implies that a member's score on one variable will correspondingly determine their score on the other variable (Kumar and Gautam, 2020). Conversely, if r is 0, it signifies no correlation between the two variables. According to Senthilnathan (2019), correlation coefficient within a range of ± 3.5 or ± 3.5 is deemed reasonable in social science. However, the correlation coefficient for social variables is often inconsistent and fluctuates frequently. Therefore, an optimal range of -3.5 to 3.5 is recommended as a fundamental spectrum for interpreting the correlation coefficient in social science studies, as illustrated in Figure 5.

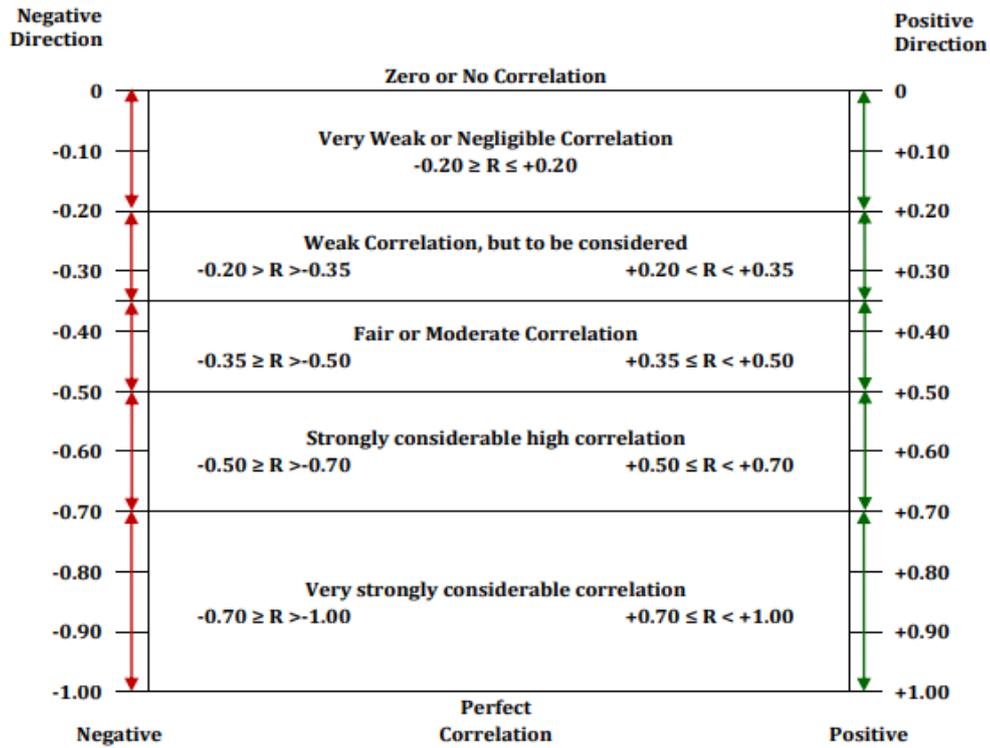


Fig. 5 The ideal range of interpretations for correlation coefficient in social science research

However, the terms are ambiguous because they do not provide precise meanings. Therefore, the coefficient of determination (*r*-square value) is applied to convey the accuracy of the prediction of the dependent variable and to provide information about how the explained value of the dependent variable relates to the independent variable with a clear and understandable meaning (Senthilnathan, 2019). The *r*-square value represents the proportion (expressed as a percentage) of the dependent variable *Y* that is explained by the variation in the independent variable *X*. Specifically, it is the square of the coefficient of correlation, *r*. *X* and *Y* represent the criteria for adaptive reuse.

2.3 Significance Testing

Significance testing, also known as hypothesis testing, is a process based on sample evidence and probability theory to determine whether a hypothesis is a reasonable statement. In statistical analysis, there is a claim that states hypotheses (null hypothesis and alternative hypothesis), followed by tests to verify and determine if the statement is true. There are five general steps in the procedure for testing a hypothesis. Figure 6 shows the cycle diagram of the procedure for testing a hypothesis.

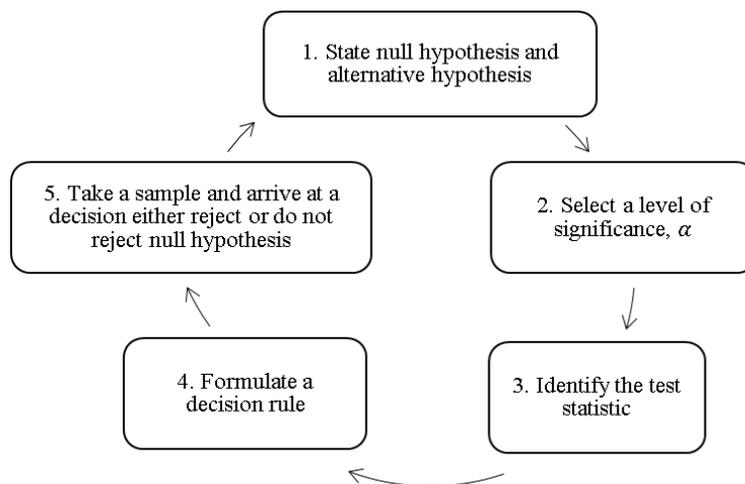


Fig. 6 Five steps procedure for testing a hypothesis

3. Data Analysis

Three specific respondents' backgrounds participated in this study: architects registered with Lembaga Arkitek Malaysia (LAM), town planners from local authorities, and valuers from the Valuation and Property Service Department (JPPH).

Table 2 States of stakeholders' responses in Malaysia

No	State	Architect	Local Authorities	JPPH	TOTAL
1	Johor	9	6	5	20
2	Perak	2	7	6	15
3	Perlis	1	0	0	1
4	Melaka	4	3	3	10
5	Selangor	15	1	4	30
6	Pahang	0	1	3	4
7	Negeri Sembilan	1	1	1	3
8	Kelantan	10	10	4	24
9	Terengganu	0	2	0	2
10	Kedah	0	1	2	3
11	Pulau Pinang	3	8	3	14
12	Kuala Lumpur	6	1	0	7
	TOTAL	51	41	31	123

Table 2 shows the stakeholders' responses representing various states in Malaysia. Architects recorded the highest number of respondents, with 51 followed by Local Authorities and JPPH with 41 and 31 respondents, respectively. Selangor had the highest number of respondents, with 24 respondents including architect firms, local authorities, and JPPH, followed by Kelantan with 24. Perlis had only one respondent from an architectural firm. The total number of respondents in this study is 123.

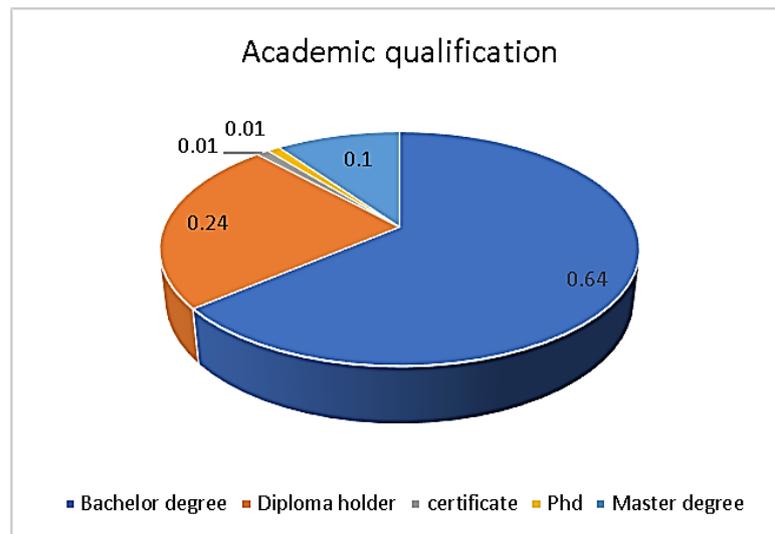


Fig. 7 Academic qualifications of respondents

Figure 7 represents the highest academic qualifications among respondents. According to the criteria for adaptive reuse, 64% of respondents have bachelor's degrees in their related fields, 24% have diplomas, and 10% have master's degrees. The remaining respondents hold certificates (1%) or Ph.D.s (1%).

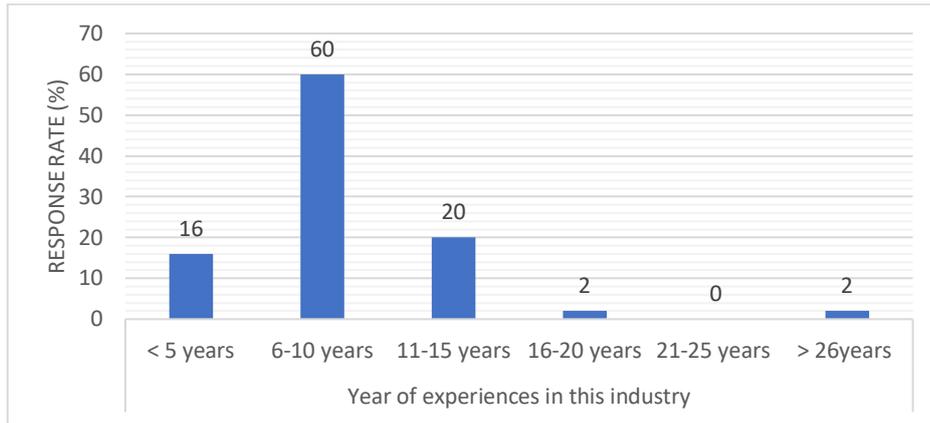


Fig. 8 Respondents' working experiences

Figure 8 illustrates the varying durations of working experience among the respondents. The majority (60%) have 6-10 years of experience, while 16% have 5 years or less of experience. The mean value, also known as the statistical average, was calculated for all 33 variables using SPSS 27. This statistical average was calculated to assess the significance of each individual variable in heritage buildings. If the mean value is the same, the average rank should be obtained.

Table 3 Significance level of criteria for adaptive reuse pre-war shophouses

Criteria for adaptive reuse	Rank	Mean		Std. Deviation	Significance level
		Statistic	Std. Error		
Client requirement	1.5	4.5122	.05581	.61891	Very significant
Available facilities	1.5	4.5122	.05210	.57781	Very significant
Building location	3	4.4715	.05455	.60497	Very significant
Building character	4	4.4472	.06131	.67996	Very significant
Site amenities	5	4.4390	.06746	.74818	Very significant
Building suitability	6	4.4228	.06110	.67761	Very significant
Material and decoration	7	4.3984	.06296	.69824	Very significant
Architectural and physical condition	8	4.3902	.06178	.68514	Very significant
Potential Market	9	4.3821	.05832	.64681	Very significant
Retaining a sense of place	10	4.3033	.07533	.83210	Very significant
Scenic	11	4.2033	.07019	.77839	Very significant
Building value	12	4.1951	.07270	.80631	Very significant
Financial reinvestment	13	4.1870	.06360	.70536	Very significant

Site Layout	14	4.1463	.06074	.67366	Very significant
Building services	15	4.0000	.07915	.87778	Very significant
Condition of integrity and authenticity	16	3.9919	.07347	.81478	significant
Environmental effect	17	3.9024	.08033	.89089	significant
Structure condition	18	3.8049	.08217	.91130	significant
Reduce the use of greenfield sites	19	3.7724	.08229	.91269	significant
Compatibility of new use with existing	20	3.7154	.06783	.75227	significant
Building system	21	3.6748	.06974	.77349	significant
Reduction of resource consumption	22	3.6585	.08548	.94807	significant
Renovation and maintenance	23	3.5854	.07738	.85820	significant
Space gain and change	24	3.5772	.07117	.78936	significant
Vacancy	25	3.5203	.08894	.98638	significant
Subsidize	26	3.4878	.09956	1.10413	significant
Neighborhood condition	27	3.4553	.09109	1.01021	significant
Role of communities	28	3.2846	.07789	.86385	significant
Social value	29	3.2520	.08452	.93733	significant
Regional development policies	30	3.2276	.08066	.89455	significant
Local's perception	31.5	3.187	.0760	.8430	significant
Building code	31.5	3.1870	.08353	.92639	significant
Official plan	33	3.1463	.09356	1.03767	significant

According to Table 3, the hypothesis being tested is as follows:

H0: All these variables significantly contribute to the heritage buildings in Malaysia.

H1: None of these variables significantly contribute to the heritage buildings in Malaysia.

Table 3 was generated after executing the provided commands in SPSS 27. It displays the mean of each variable on a five-point scale, indicating the significance level of each of the thirty-three variables and arranging them in descending order of mean. The suitability of the adaptive reuse alternative was assessed based on the mean level. As per the criteria proposed by Talib et al. (2014), the adaptive reuse criteria remain appropriate as their values exceed 3.00. The results in Table 3 indicate that the null hypothesis is accepted, signifying that all these variables (criteria) significantly contribute to heritage buildings in Malaysia.

3.1 Correlation Analysis

Following the descriptive analysis, correlation analysis was employed to investigate the interrelationships among the criteria influencing the potential new use of pre-war shophouses. In this research, Pearson’s correlation analysis was utilized to assess the strength of connections among the criteria. A high correlation value indicates a robust relationship between two criteria, while a low value suggests a weaker relationship. The 33 criteria were categorized into six distinct aspects: economic, environmental, social, technological, legislative, and architectural. Table 4 displays the mean results based on these six crucial aspects, reflecting responses from 123 participants. Additionally, Table 5 presents the outcomes of Pearson correlation analysis, applied to examine parametric data, revealing the correlation size and relationships among the criteria.

Table 4 Mean of the criteria after being grouped into six aspects

Aspect	Mean	Std. Deviation
Architecture	4.1080	.69104
Economy	3.5496	.77738
Social	3.7984	.83901
Environment	3.9837	.75066
Technology	3.3882	.85543
Legislative	4.2493	.62045

Table 5 Pearson’s correlation analysis among six broad parameters

Aspect		Architecture	Economy	Social	Environment	Technology	Legislative
Architecture	Pearson Correlation	1	.948**	.936**	.968**	.902**	.965**
Economy	Pearson Correlation	.948**	1	.954**	.944**	.960**	.937**
Social	Pearson Correlation	.936**	.954**	1	.949**	.923**	.918**
Environment	Pearson Correlation	.968**	.944**	.949**	1	.899**	.948**
Technology	Pearson Correlation	.902**	.960**	.923**	.899**	1	.893**
Legislative	Pearson Correlation	.965**	.937**	.918**	.948**	.893**	1

Talib et al. (2014) noted that a correlation size value of 0.90 to 1.00 indicates a very high positive correlation. Table 5 displays the correlation size values among the six criteria for adaptive reuse of pre-war shophouse buildings, all of which were found to be very strongly correlated (greater than 0.90). Architecture-environment had the highest correlation size value at 0.968, followed by architecture-legislative with a value of 0.965. Technology-legislative had the lowest correlation value at 0.893, still falling within the range of very high correlation. Table 6 presents the model summary and parameter estimates related to the regression analysis. R-squared, also known as the coefficient of determination, is a measure that is more easily interpreted than the terms and a precise meaning.

Table 6 Model summary and parameter estimates

Dependent - independent	Equation	Model Summary			Parameter Estimates	
		R square	F	Sig.	Constant	b1
Architecture - Economy	Linear	.899	1082.122	.000	1.116	.843
Architecture -Social	Linear	.876	852.720	.000	1.180	.771

Architecture - Environment	Linear	.938	1826.259	.000	.556	.892
Architecture - Technology	Linear	.814	528.654	.000	1.639	.729
Architecture - Legislative	Linear	.932	1657.218	.000	-.461	1.075
Economy - Social	Linear	.910	1224.569	.000	.192	.884
Economy - Environment	Linear	.891	988.637	.000	-.345	.978
Economy - Technology	Linear	.922	1432.812	.000	.593	.873
Economy - Legislative	Linear	.878	872.856	.000	-1.440	1.174
Social - Environment	Linear	.900	1090.021	.000	-.426	1.060
Social - Technology	Linear	.851	691.407	.000	.733	.905
Social - Legislative	Linear	.842	645.838	.000	-1.475	1.241
Environment - Technology	Linear	.808	507.849	.000	1.312	.789
Environment - Legislative	Linear	.899	1081.898	.000	-.892	1.147
Technology - Legislative	Linear	.797	474.720	.000	-1.842	1.231

According to the information above, it seems that the r square value for architecture and economy is 0.899, meaning that the variation in the economy explains 89.9% of the variation in the response variable in architecture. Meanwhile, b_1 and constants represent the regression equation for each dependent and independent variable. According to Hernowo (2015), historical buildings symbolize historical, symbolic, and authentic value represented by the existence of facades and also serve as economic generators of value for new interior constructions. In terms of architecture, heritage facadism is a subset of postmodernism. It is viewed as a compromise between past and present development, or perhaps what the cultural industry might refer to as the economization of cultural commodities. This result is consistent with the study conducted by Wang & Zeng (2010) where architectural value is parallel to social value, and they are interdependent. Preserving architectural value during the adaptive reuse process increases cultural and social value. Salameh et al. (2022) found that heritage conservation has direct positive impacts on all aspects of sustainability, including the environment and socioeconomic factors. A study on the impact of historical preservation on citizens' identity, social life, and sense of belonging in the old city of Nablus found a positive influence. The result is consistent with the information above, where the highest correlation among the criteria for adaptive reuse is between architecture and environment, which is 93.8%. Hypothesis testing is used to provide robust evidence regarding the statement above. Let ρ represent the correlation in the population. The null and alternative hypotheses are:

$H_0: \rho=0$ (The correlation between the population is zero, meaning there is no correlation.)

$H_1: \rho \neq 0$ (The correlation in the population is different from zero, which has a correlation)

Using a significance level of 0.05, the critical t is determined to be 2.306. Since this is a two-tail test, the decision rule is that the null hypothesis is rejected if the calculated $t > 2.306$ or calculated $t < -2.306$. Consider the r value is 0.886, which is the smallest value from the analysis above.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = \frac{0.886\sqrt{128-2}}{\sqrt{1-0.886^2}} = 21.448 \quad (2)$$

Since the calculated $t > 2.306$, we reject H_0 and conclude that there is strong evidence to suggest the correlation in the population is not zero. Therefore, the statement is supported and it means that there is strong correlation between the criteria for adaptive reuse. In the context of heritage buildings, particularly pre-war shophouses, such high correlations indicate that the six broad parameters such as architectural value, historical importance, structural integrity, and others do not operate in isolation. Instead, these criteria work together as a cohesive set of influences that are integral to evaluating a building's worth for preservation. For instance, a building's architectural value may often correspond with its historical significance. This shows that heritage preservation efforts should selectively prioritize specific high-impact categories while maintaining the entire assessment's integrity. Furthermore, the data in Table 6 show that none of the criteria are significantly weaker, showing that each makes a meaningful contribution to the framework of heritage values. The six broad parameters are well-rounded for assessing the importance of heritage buildings.

4. Conclusion

In essence, correlation is one of the most used statistical methods for assessing the strength of a relationship between two variables. Correlation can be categorized as positive, negative, or not correlated based on the correlation coefficient (r) value. One can calculate correlation manually using the formula or utilize readily available statistical analysis software like Microsoft Excel or SPSS. The analysis of variables selected from heritage buildings indicates that all the thirty-three criteria considered are strongly positively correlated, with values ranging from 0.90 to 1.00. The six criteria were found to be highly interdependent, and the significant correlation coefficient values provide strong evidence that the correlation within the population is not zero. This high correlation reinforces that these criteria should be viewed as a collective framework when evaluating buildings for preservation. Each criterion contributes value to the assessment process, ensuring a balanced and holistic approach. The questionnaire results reveal that no item is significantly lower than other elements, but many are notably higher in comparison to several elements. From a practical perspective, strong interdependence allows decision-makers to focus on key factors that inherently represent others, streamlining assessments while maintaining rigor. Importantly, this interrelated framework supports environmentally sustainable preservation practices by reducing the need for new construction and encouraging the reuse of existing structures. This study provides a solid basis for future preservation guidelines, underscoring the cultural, historical, and environmental importance of heritage buildings, particularly pre-war shophouses in Malaysia.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Azeanita Suratkon, Nur Ain Ebas, Yunita Dian Suwandari; **data collection:** Muhamad Shahril Mohd Abdullah; **analysis and interpretation of results:** Nur Ain Ebas, Muhamad Shahril Mohd Abdullah, Siti Afiqah Jamil; **draft manuscript preparation:** Nur Ain Ebas. All authors reviewed the results and approved the final version of the manuscript.

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