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The Role of Adaptive Reuse in Revitalizing Abandoned Buildings in Malaysia

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Abstract

In the context of urban development constraints, adaptive reuse of abandoned buildings in Malaysia presents a promising opportunity. While abandoned buildings contribute to significant economic and environmental challenges, they also hold considerable potential for revitalization through adaptive reuse projects. This study explored the key factors influencing the adaptive reuse of buildings and the challenges encountered in such initiatives. The primary aim was to examine the role of adaptive reuse in revitalizing abandoned buildings in Malaysia. Employing a Delphi study approach, data was collected from industry professionals through a questionnaire survey, which identified the factors and challenges associated with adaptive reuse projects. The study revealed several key consideration factors, including government incentives, originality, actors in decision-making, environmental and architectural merit, and social interest. Additionally, it highlighted critical challenges, such as maintenance issues, building code compliance, constraints in building performance, complications arising from multiple ownership, and uncertainties regarding renovation processes. The findings provide valuable insights and recommendations for policymakers, developers, and urban planners, advocating for a sustainable urban development model that leverages adaptive reuse to enhance economic resilience and environmental preservation in Malaysia. The study's limitations include a narrow focus on the Malaysian context and the reliance on expert opinions, which may not fully capture the perspectives of all stakeholders. Future research could address these limitations by broadening the scope to include more diverse perspectives and exploring additional case studies in different regions.

1. Introduction

Adaptive reuse is a key approach in architectural and urban planning that repurposes existing buildings for new uses while preserving their historical, cultural, or architectural value. Globally, this method has gained significant attention for addressing sustainability concerns by reducing demolition waste, conserving embodied energy, and minimizing the environmental footprint of new construction [1]. In Malaysia, adaptive reuse holds considerable potential due to the country's diverse architectural heritage, which encompasses colonial, vernacular, and modern styles. Nevertheless, many buildings, both heritage and non-heritage, remain abandoned, presenting a dual challenge and opportunity for adaptive reuse.

The issue of abandoned buildings in Malaysia is particularly pressing in urban areas, where these structures often result from economic downturns, shifts in urban development priorities, or insufficient maintenance. These

neglected buildings contribute to urban decay, safety hazards, and inefficient land use while offering untapped potential for transformation into functional and aesthetically appealing spaces [2]. Adaptive reuse presents a viable strategy for revitalizing such buildings, aligning with Malaysia's goals for sustainable urban development, economic growth, and cultural preservation [3].

Several successful adaptive reuse initiatives in Malaysia demonstrate the viability of this approach. Notably, the Zhongshan Building in Kuala Lumpur, once a derelict row of shophouses, has been converted into a vibrant cultural and creative hub [4]. These projects illustrate the capacity of adaptive reuse to create social, economic, and environmental value. In Papan, for instance, abandoned heritage buildings have been identified for their potential to become tourism attractions. Research indicates that with appropriate adaptive reuse strategies, these structures could be transformed into tourist sites, contributing to local economic growth and heritage conservation [5].

Despite these promising examples, adaptive reuse remains underutilized in Malaysia. Developers, policymakers, and stakeholders encounter numerous obstacles, including financial constraints, technical difficulties, regulatory hurdles, and cultural perceptions. Abandoned buildings, in particular, pose unique challenges, such as structural degradation, lack of historical documentation, and unclear ownership. Overcoming these barriers necessitates a comprehensive understanding of the consideration factors adaptive reuse in Malaysia.

Economic feasibility is one of the primary challenges hindering adaptive reuse. Retrofitting abandoned buildings to meet modern building codes and standards often requires substantial investment. Developers may view these costs as prohibitive compared to new construction, discouraging participation in such [1]. Furthermore, Malaysia's regulatory frameworks are inconsistent, with heritage laws and zoning restrictions complicating the adaptive reuse process. Technical issues, including structural integrity concerns, outdated construction materials, and the need to adhere to modern safety regulations, further exacerbate the situation. Additionally, cultural and social attitudes play a critical role in shaping the adaptive reuse landscape. Public perception frequently undervalues abandoned buildings, viewing them as liabilities rather than opportunities. This is compounded by limited awareness of the potential economic, environmental, and social benefits of adaptive reuse [6].

Although significant progress has been made in adaptive reuse research, further exploration is essential to improve its practical application in existing buildings. This is particularly urgent given the ongoing global challenges posed by the COVID-19 pandemic and persistent socio-economic and environmental issues. Future research should focus on the reuse potential of abandoned or underutilized buildings, as adaptive reuse could drive innovation, urban renewal, and sustainable development by offering creative solutions to contemporary challenges [7].

In Malaysia, abandoned buildings present a critical opportunity for urban regeneration, architectural heritage preservation, environmental sustainability, and economic stimulation. However, addressing regulatory barriers, technical complexities, and financial constraints is imperative for successful implementation. This research is vital for Malaysia's development, as adaptive reuse aligns with global sustainable development goals and national urbanization strategies. By addressing housing shortages, improving urban livability, and reducing environmental impact, adaptive reuse can contribute significantly to building resilient cities. Therefore, this study aims to identify the consideration factors and examine the challenges of the adaptive reuse of buildings, providing stakeholders with valuable insights to promote adaptive reuse as a sustainable urban development strategy.

2. Literature Review

2.1 Adaptive Reuse of Abandoned Buildings in Malaysia

Adaptive reuse of abandoned buildings in Malaysia has gained traction as a sustainable solution to urban decay and the preservation of cultural heritage. This practice involves repurposing existing structures for new uses, thereby reducing the need for new construction and minimizing environmental impact. With a rich architectural history, Malaysia is home to numerous abandoned and underutilized buildings that present unique opportunities for transformation. Projects such as the Kuala Lumpur Performing Arts Centre (KLPAC) and RexKL exemplify successful adaptive reuse efforts that not only restore historical significance but also contribute to community revitalization and economic development. As cities face increasing challenges related to urbanization, adaptive reuse emerges as a viable strategy to breathe new life into neglected spaces while promoting sustainability and cultural continuity [8].

2.2 Case Studies of Successful Adaptive Reuse Projects in Malaysia

Malaysia presents numerous opportunities for the adaptive reuse of historical buildings. Notable examples of successful reuse include the Sekeping projects, which have fully transformed heritage structures, such as Sekeping Kong Heng in Perak, Sekeping Victoria and Sekeping Pinang in Penang, as well as Sekeping Sin Chew Kee and

Sekeping Backland in Kuala Lumpur. The adaptive reuse of existing building stock contributes significantly to energy and resource conservation. Furthermore, modern methods and green technologies can be integrated to enhance building performance, creating healthier environments for living and working. The importance of such transformations lies in their focus on sustainability. By incorporating eco-friendly materials and innovative design strategies, these projects serve as pioneering models for green adaptive reuse in Malaysia, offering a practical framework for sustainable urban renewal [9].

A notable example is the transformation of pre-war shophouses into the Penaga Hotel in Penang. This project involved converting dilapidated structures into a boutique hotel, addressing challenges including structural reinforcement and compliance with modern building standards. The adaptive reuse not only conserved the historical architecture but also revitalized the area by attracting tourism and economic activity [10]. Figure 1 illustrates the building before and after adaptive reuse.

(a) **(b)**

Fig. 1 *Structure of Penaga Hotel (a) Penaga Hotel before adaptive reuse; (b) Penaga Hotel after adaptive reuse [10]*

Another significant case is the Asia Heritage Row in Kuala Lumpur, where 80-year-old pre-war houses were repurposed into elegant restaurants, cafes, and bars. This initiative preserved the buildings' heritage significance and enhanced social sustainability by creating spaces for community interaction. The project demonstrated that adaptive reuse could maintain cultural values while ensuring the buildings' functionality and sustainability [11]. The building before and after applied adaptive reuse shown in Figure 2.

(a) **(b)**

Fig. 2 *Asia heritage row building (a) The row before Adaptive reuse; (b) The row before Adaptive reuse (Source: https://www.studiobikin.com/the-row.php)*

The Zhongshan Building in Kuala Lumpur is an example of successful adaptive reuse for residential purposes, blending local wisdom with heritage conservation. Originally built in the 1950s as a row of interconnected shophouses, the building was transformed into a cultural and creative hub, featuring residential units, art galleries, studios, and retail shops as shown in Figure 3. The project emphasized preserving the building's original façade and layout, preserving its historical value and fostering a sense of belonging for the local community. This project demonstrates that adaptive reuse can enhance heritage buildings' functionality, promote cultural continuity, and contribute to sustainable urban living. Collaboration between architects, conservationists, and the

local community is crucial for achieving a balanced outcome that respects the building's historical integrity while ensuring economic and social relevance [4].

(a) **(b)**

Fig. 3 *Building of Zhongshan (a) Zhongshan in 2016, before it became a creative hub; (b) Current Zhongshan building after reconstrustion (source: https://www.instagram.com/thezhongshanbuilding/)*

3. Research Methodology

This study employed a Delphi study approach; data were collected from industry professionals through a questionnaire survey, which identified the factors and challenges associated with adaptive reuse projects. The process starts by collecting expert consensus on the factors and challenges of adaptive reuse of buildings in Malaysia from the previous findings from the literature review, then correlating informed judgments regarding an idea that spans a wide range of perspectives. This, together with a systematic literature review, identified 22 consideration factors and 20 challenges in Round 1 of implementing adaptive reuse for abandoned buildings in Malaysia. The Delphi study was then conducted to further identify, verify, and prioritise the 22 consideration factors and 20 challenges found.

3.1.1 Delphi Survey

The Delphi technique is a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. To accomplish this "structured communication" there is provided: some feedback of individual contributions of information and knowledge; some assessment of the group judgment or view; some opportunity for individuals to revise views; and some degree of anonymity for the individual responses [12]. It is one of the approach used to gain consensus through a series of rounds of questionnaire surveys, usually two or three, where information and results are fed back to panel members between each round [13].

A total of 15 potential panellists, including developers, architects, town planner, and engineers in construction field from Malaysia was targeted. Out of these, 12 of them showed their interest and willingly consented to be part of this study. Nevertheless, out of 12 panelists, one dropped out after the first round of the Delphi survey, and only 11 completed the whole study. A cross section of the construction industry was well depicted by the participants. The panellists included two architect, seven engineers and three contractors, as illustrated in Table 1. The survey reveals a balanced distribution of construction industry experience, with two participants having less than five years of experience, two having 11 to 15 years, and two having 16 to 20 years. The largest group has over 20 years of experience. Out of twelve panelists, six have direct involvement in adaptive reuse building projects, while the remaining six have no prior experience. The majority of these panelists have worked on one to two projects, with one participating in three to five.

Table 1 *Profile of the Delphi panellists*

Panellisits	Role in construction industry	Years of experience in construction industry (years)	Numbers of project adaptive reuse
P1	Engineer	> 20	> 5
P2	Engineer	< 5	-
P3	Architect	> 20	1-2
P4	Contractor	16 -20	1-2
P5	Engineer	11 – 15	-
P6	Engineer	5 -10	3-5
P7	Contractor	< 5	-
P8	Engineer	11 – 15	-
P9	Engineer	> 20	-
P10	Engineer	5 – 10	> 5
P11	Contractor	> 20	-
P12	Architect	16 – 20	1-2

The Delphi survey data were analysed by means and ranks. Mean ratings of 4.0 or above are considered to be high and significant. The level of agreement and inter-quartile range (IQR), the difference between the 75th and 25th percentiles, are calculated to recognise the consensus level of each item, the latter being used to assess the dispersion of the ratings – the lower the IQR, the less dispersed the data points and, therefore, leading more towards a consensus. The level of agreement for each item is given by

$$\text{Level of agreement (\%)} = \frac{\sum panellists\ who\ rate\ 1\ and\ 2}{Total\ number\ of\ panellist} \times 100\%$$

whereby by scoring "I" and "2", the panellists considered the items as irrelevant or not important, and

$$\text{Level of agreement (\%)} = \frac{\sum panellists\ who\ rate\ 4\ and\ 5}{Total\ number\ of\ panellist} \times 100\%$$

Total number of panellists by scoring "4" and "5", the panellists agreed that the items were relevant or important.

The study established consensus primarily using an Interquartile Range (IQR) of 1.0 or less, reflecting a narrow range of responses among the panellists. Recognizing that IQR alone might not fully capture the level of agreement, particularly for items with an IQR of exactly 1.0 [14], a supplementary criterion was applied to enhance the consensus determination process. This additional measure required at least 60% agreement among panellists for an item to be deemed relevant or irrelevant. Items rated as "1" or "2" by 60% or more of panellists were considered irrelevant and excluded, while those rated as "4" or "5" by 60% or more were retained for further analysis. Items with an IQR exceeding 1.0, indicating considerable variability in responses, were included in the second round of the questionnaire to facilitate further refinement.

4. Results and Discussion

4.1 Consideration Factors for Adaptive Reuse Buildings

Table 2 summarizes the panelists' ratings of the consideration factors for the adaptive reuse of buildings in Rounds 1 and 2 of the Delphi survey. In Round 1, all factors were rated as important, with agreement levels exceeding 60%. Early consensus was achieved for most criteria, with over 80% agreement on their relevance. However, three factors—"political," "environmental," and "cultural"—did not reach consensus because their interquartile ranges (IQRs) exceeded 1.0, indicating variability in responses. These factors were re-evaluated in Round 2, where agreement levels improved, ultimately achieving consensus for all factors. A total of 22 consideration factors were identified, with mean ratings calculated for each.

Table 2 *Rating result for the consideration factors for adaptive reuse of buildings in Malaysia*

Item	Factor	IQR	Levvel of Agreement (%)		Reached Consensus?
			Strongly Disagree	Strongly Agree	
ROUND 1					
1	**Lifecycle Issues** Extending building life by addressing maintenance and adapting to new needs	0.75	0%	92%	YES
2	**Changing Perceptions of Building** Increased value placed on re-use for historic or sustainability reasons	1.00	0%	92%	YES
3	**Government Incentives** Financial and regulatory incentives that support adaptive re-use	0	0%	100%	YES
4	**Planning Regulations** Need for zoning and planning adjustments to enable industrial-to-residential conversion	1.00	17%	83%	YES
5	**Housing Affordability** Adaptive reuse as a solution to increase affordable housing supply	0.75	0%	83%	YES
6	**Actors in Decision-Making** Influence of various stakeholders, including investors, regulators, and users	0	0%	100%	YES
7	**Analysis of Existing Fabric** Assessment of original function, heritage, and district needs	1.00	0%	92%	YES
8	**Conservation Actions** Required restoration/modifications to maintain or improve building condition	1.00	0%	100%	YES
9	**Decision of New Function** Selecting an appropriate function that addresses sustainability and market trends	1.00	0%	92%	YES
10	**Originality** Historical value, authenticity, and uniqueness of the building	0	0%	100%	YES
11	**Architectural Merit** Aesthetic appeal, local distinctiveness, and harmony with surroundings	0.75	0%	100%	YES
12	**Social Interest** Community identity, societal memory, and public access	0.75	0%	100%	YES
13	**Group Value** Interests of stakeholders, including job creation and business opportunities	1.00	0%	100%	YES
14	**Intervention** Physical changes needed for safety, accessibility, and structural stability	1.00	0%	92%	YES
15	**Political** Alignment with government, zoning regulations, and urban planning	1.75	0%	75%	NO
16	**Building Location** Evaluating the advantages of the building's location	1.00	0%	92%	YES
17	**Available Infrastructure in the Surrounding Area** Assessing access to essential infrastructure availability in the vicinity of the building	1.00	0%	83%	YES

Item	Factor	IQR	Levvel of Agreement (%)		Reached Consensus?
			Strongly Disagree	Strongly Agree	
ROUND 1					
18	**Cost** Financial feasibility, including initial investment, cost savings, and potential financial benefits	1.00	0%	100%	YES
19	**Technical/ Technological** Adaptability, physical characteristics, and circular construction goals	1.00	0%	92%	YES
20	**Environmental** Emphasis on reducing energy consumption, protecting resources, and creating green spaces	1.75	0%	75%	NO
21	**Cultural** Enhancing cultural heritage and community significance to attract tourism	1.75	0%	75%	NO
22	**Administrative** Collaboration, participatory governance, and citizen engagement	1.00	0%	100%	YES
ROUND 2					
15	**Political** Alignment with government, zoning regulations, and urban planning	1.00	-	82%	YES
20	**Environmental** Emphasis on reducing energy consumption, protecting resources, and creating green spaces	0	-	100%	YES
21	**Cultural** Enhancing cultural heritage and community significance to attract tourism	1.00	-	100%	YES

Overall, the most important factors to be considered of adaptive reuse for buildings were “government incentives” under category economical, followed by “environmental” categorise under technical and technological and category social and culture for factor “originality”. "Architectural merit," classified as a physical consideration, ranked fourth, while "actors in decision-making," under political considerations, were recognized as significant stakeholders in adaptive reuse projects. Functional considerations, such as "house affordability," were also highlighted. The categorical chart in Figure 4 also shows that economical, followed by technical, also social and culture, was the most important consideration factor implementing adaptive reuse of buildings. Meanwhile, the lowest ranked factors were “planning regulations”. These factor represent legal.

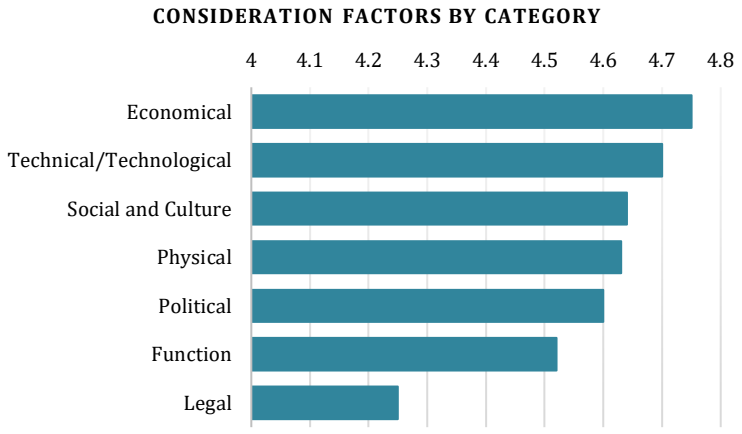

Fig. 4 *Consideration factors of adaptive reuse buldings by category*

4.1.1 Economical Consideration

Economically, government incentives emerged as the most significant factor, as noted by Shipley et al. (2006), who emphasized their role in encouraging redevelopment and enhancing property values, thereby generating long-term economic returns. Additionally, the cost-effectiveness of adaptive reuse compared to demolition and reconstruction, as highlighted by [15], makes it an attractive option, particularly in an era of rising energy prices. Stakeholder group value was also critical, encompassing collective benefits like job creation, community engagement, and public facility development [16].

4.1.2 Technical/Technological Consideration

Technologically, environmental factors play a pivotal role in promoting sustainability through reduced energy consumption, resource conservation, and waste minimization. This aligns with the principles of the circular economy [17]. Ensuring structural adaptability and technological upgrades to meet modern standards is vital for the success of these projects [18].

4.1.3 Social and Cultural Consideration

Social and cultural considerations include the originality and historical value of buildings, which foster cultural identity and community cohesion. Preserving authenticity while accommodating modern functions requires careful planning [19]. Administrative collaboration among stakeholders ensures that adaptive reuse respects historical significance and serves contemporary needs [20].

4.1.4 Physical Consideration

Physical considerations are crucial in the adaptive reuse of buildings, with architectural merit being a primary factor due to the impact of adaptive reuse on building systems and layouts [21]. The building's physical condition, ranging from minimal deterioration to severe damage, influences its reuse potential [22]. Key considerations include lifecycle issues, conservation strategies, and the building's lifespan, which determines whether it is suitable for retention or demolition [23]. Intervention factors, such as structural alterations, compliance with building codes, accessibility, and safety, were also emphasized, with a focus on adapting the building for diverse users, including the disabled and elderly [16]. Furthermore, analyzing the building's original function, heritage value, and physical characteristics is essential to preserve its identity while adapting it for contemporary use, ensuring long-term sustainability within the urban context [22].

4.1.5 Political Consideration

Politically, the role of key actors such as regulators, investors, and community groups is crucial in shaping adaptive reuse strategies. Compliance with urban master plans and regional policies, alongside stakeholder engagement, facilitates balanced heritage preservation and sustainable urban growth [24].

4.1.6 Functional Consideration

Functionally, affordability and location accessibility are consideration factors of reuse feasibility. Strategies include maintaining original functions, introducing mixed-use developments, or completely repurposing buildings, depending on contextual needs [22].

4.1.7 Legal Consideration

Legally, adherence to safety regulations, building codes, and planning policies ensures the structural stability and environmental performance of reused buildings. Compliance with international standards such as OSHAS and ASHRAE enhances occupant safety and environmental quality [24].

4.2 Challenges of Adaptive Reuse of Buildings

Table 3 presents the findings from the panelists' ratings of the challenges associated with implementing adaptive reuse of buildings in Malaysia, as assessed in both rounds of the Delphi survey. In Round 1, a consensus was reached for eight items, with four key challenges, "maintenance", "building code compliance", "uncertainty of renovation issues", and "creative design challenges", which receiving unanimous agreement. However, 12 items did not achieve consensus and were carried forward to Round 2 for further evaluation. In Round 2, two items which are "financial" and "technical perceptions", and "market reluctance and demand", failed to meet the consensus threshold due to non-compliance with the interquartile range (IQR) cut-off and insufficient percentage of agreement. Despite this, consensus was achieved for the remaining nine items, resulting in a total of 20

identified challenges. The mean ratings for each challenge were subsequently calculated to provide a quantitative overview of their relative significance.

Table 3 *Rating results for the challenges of adaptive reuse of buildings*

Item	Challenges	IQR	Levvel of Agreement (%)		Reached Consensus?
			Strongly Disagree	Strongly Agree	
ROUND 1					
1	**Maintenance** High repair costs of deteriorated structures impacting adaptive reuse viability	0	0%	100%	YES
2	**Building Code Compliance** Adherence to current building regulations and conservation guideline	0.75	0%	100%	YES
3	**Classification Changes** Zoning adjustments needed to support new functions	1.00	0%	92%	YES
4	**Risks to Commercial Value** Perceived risks in profit related to the implementation of building adaptive reuse	1.00	0%	92%	YES
5	**Uncertainty of Renovation Issues** Unforeseen renovation issues encountered during adaptive reuse projects	1.00	0%	100%	YES
6	**Financial and technical perceptions** Destruction as a perceived cost-effective option, making reuse less appealing	2.00	0%	67%	NO
7	**Technical Complexity** Retrofitting modern systems into older structures	1.00	0%	83%	YES
8	**Material Availability** Availability of appropriate materials for conservation projects	2.00	0%	67%	NO
9	**Availability of Skilled Labor** Accessibility and availability of skilled labor for adaptive reuse projects	2.00	8%	67%	NO
10	**Stakeholder Resistance** Conflicting interests among owners, tenants, and local authorities	1.75	8%	42%	NO
11	**Multiple Ownership Issues** Complications from multiple ownerships that delay reuse initiatives	2.00	8%	67%	NO
12	**Physical and Structural Constraints** Necessary structural adjustments to accommodate permissible building loads	2.00	0%	67%	NO
13	**Safety Constraints** Required structural modifications to ensure the building's safety	2.00	8%	67%	NO
14	**Building Performance Constraints** Structural modifications required for ventilation within the building	1.75	0%	75%	NO
15	**Insufficient Government Incentives** Limited financial support discouraging adaptive reuse projects	1.75	8%	75%	NO
16	**Market Reluctance and Demand** Private owners' hesitancy due to unclear market demand	2.00	0%	50%	NO

Item	Challenges	IQR	Levvel of Agreement (%)		Reached Consensus?
			Strongly Disagree	Strongly Agree	
ROUND 1					
17	**Economic consideration** Direct and indirect costs in adapting buildings to conservation standards	2.00	0%	67%	NO
18	**Social consideration** Intangible social values and community attachment to places	1.75	0%	50%	NO
19	**Environmental Constraints** Pollution, noise, and contamination issues affecting adaptive reuse potential	1.00	8%	92%	YES
20	**Creative and Design Challenges** Challenges in integrating design with functional changes due to limited spatial flexibility	1.00	0%	100%	YES
ROUND 2					
6	**Financial and technical perceptions** Destruction as a perceived cost-effective option, making reuse less appealing	2.00	-	64%	NO
8	**Material Availability** Availability of appropriate materials for conservation projects	1.00	-	91%	YES
9	**Availability of Skilled Labor** Accessibility and availability of skilled labor for adaptive reuse projects	1.00	-	91%	YES
10	**Stakeholder Resistance** Conflicting interests among owners, tenants, and local authorities	1.00	-	100%	YES
11	**Multiple Ownership Issues** Complications from multiple ownerships that delay reuse initiatives	1.00	-	91%	YES
12	**Physical and Structural Constraints** Necessary structural adjustments to accommodate permissible building loads	1.00	-	100%	YES
13	**Safety Constraints** Required structural modifications to ensure the building's safety	1.00	-	82%	YES
14	**Building Performance Constraints** Structural modifications required for ventilation within the building	1.00	-	100%	YES
15	**Insufficient Government Incentives** Limited financial support discouraging adaptive reuse projects	1.00	-	100%	YES
16	**Market Reluctance and Demand** Private owners' hesitancy due to unclear market demand	2.00	-	64%	NO
17	**Economic consideration** Direct and indirect costs in adapting buildings to conservation standards	1.00	-	91%	YES
18	**Social consideration** Intangible social values and community attachment to places	1.00	-	91%	YES
14	**Building Performance Constraints** Structural modifications required for ventilation within the building	1.00	-	100%	YES

Most of the challenges were rated above 4.0, indicating that the panelists found it difficult to determine their relevance. As shown in Figure 5, the most significant challenge for the adaptive reuse of buildings was economic, particularly the issue of "maintenance," with high repair costs of deteriorated structures severely affecting the viability of reuse. This was followed by legal challenges related to "building code compliance," which involved adherence to current regulations and conservation guidelines. Functional challenges, particularly the "uncertainty of renovation issues," ranked next. The fifth-ranked challenge was political, specifically "stakeholder resistance," which stemmed from conflicting interests among owners, tenants, and local authorities. Technical challenges, such as the "availability of skilled labor," were also noted. The lowest-ranking challenge was social, relating to intangible social values and community attachment to places.

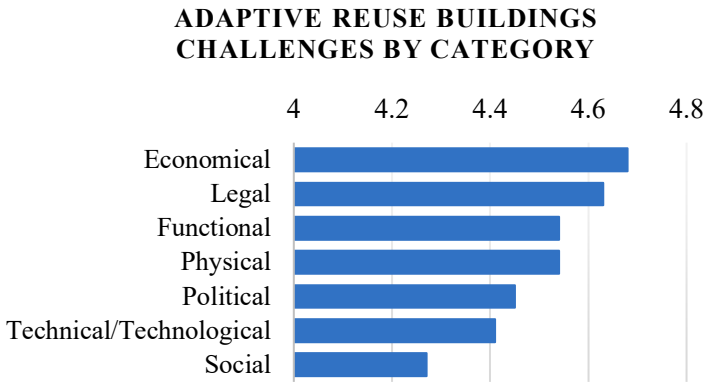

Fig. 5 *Challenges of adaptive reuse of buildings by category*

4.2.1 Economic Challenges

Panelists overwhelmingly identified maintenance as the most significant challenge, with a high mean score of 4.83. The evaluation of a building's physical and operational condition for reuse is a time-consuming process that often reveals extensive deterioration, necessitating costly repairs. When maintenance costs become too high, adaptive reuse may become economically unfeasible [1]. Financial challenges are intrinsic to all stages of adaptive reuse, with high repair costs, defects, and additional expenses due to conservation requirements for heritage buildings being burdensome for developers [25]. Furthermore, extended renovation timelines and complex adaptation processes tend to reduce profit margins, deterring private investment [1]. Insufficient government incentives were also cited as a challenge, particularly for small entrepreneurs lacking the financial resources to undertake adaptive reuse projects [26].

Additionally, market reluctance and the perceived high costs of adaptive reuse hinder private developers, as some view demolition as the only profitable option. This is further compounded by a lack of clear market demand, which has slowed the adoption of reuse practices [1][26].

4.2.2 Legal Challenges

Legal hurdles are significant, with compliance to building codes, conservation guidelines, and zoning requirements complicating adaptive reuse projects [1][21][26]. The absence of clear legal guidelines for adaptive reuse, especially in heritage sites, results in uncontrolled renovations, diminishing architectural integrity [27]. Additionally, issues with multiple ownership structures, particularly in industrial buildings, lead to delays and hinder project progress [26].

4.2.3 Functional Challenges

Functional challenges often arise from uncertainties related to renovation needs, such as reconfiguring internal spaces and upgrading outdated services [16]. Adaptive reuse projects also require creative design solutions to meet modern standards while preserving the structural integrity of aging buildings. The extensive regulatory requirements for alterations add further complexity [21].

4.2.4 Physical Challenges

Physical constraints, such as upgrading older buildings to meet current performance standards, present a significant obstacle [28]. Modifications are often required to ensure compliance with modern safety and accessibility standards, which increases costs and complicates the reuse process. Spatial limitations and safety concerns further challenge contractors [29][30].

4.2.5 Political Challenges

Political challenges often stem from stakeholder resistance, particularly when there are conflicting interests among community members and developers. Such disagreements can lead to the abandonment of adaptive reuse projects, especially if the local community perceives the proposed changes as incompatible with their needs [31].

4.2.6 Technical/Technological Challenges

The technical complexity of adaptive reuse, including the integration of modern services like air-conditioning systems into older buildings, poses a challenge. The need for specialized skills and careful planning is critical to overcoming the difficulties of retrofitting older buildings [32].

4.2.7 Social Challenges

Social challenges, including resistance to changes in heritage buildings and a lack of awareness regarding sustainable practices, complicate adaptive reuse efforts. Community attachment to historical buildings and a lack of motivation to adopt green concepts hinder the success of these projects [24].

5. Conclusion

This study provided valuable insights into the critical consideration factors and challenges related to the adaptive reuse of abandoned buildings in Malaysia. Through the Delphi survey, it identified key elements such as government incentives, originality, and stakeholder collaboration as vital to the success of adaptive reuse projects. Financial and regulatory support, along with a focus on sustainability and cultural preservation, were found to be essential for enhancing the viability of such projects. These findings offer a comprehensive framework for promoting adaptive reuse as an effective strategy for revitalizing abandoned buildings and contributing to sustainable urban development.

The study also identified several challenges, including economic, legal, functional, political, technical, and social barriers. High repair costs, regulatory compliance, and stakeholder resistance emerged as the most significant hurdles. Strategies to address these challenges include financial incentives, streamlined regulatory processes, and improved collaboration among stakeholders. Additionally, technical challenges such as the availability of skilled labor and the integration of modern services into older buildings require innovative solutions. Social challenges, particularly preserving cultural identity, can be mitigated through public awareness and community engagement. These findings underscore the complexity of adaptive reuse and highlight the need for targeted strategies to overcome these barriers..

The study on adaptive reuse in Malaysia has limitations due to limited participants, time constraints, and evolving research. Future research should include broader stakeholder involvement, economic, legal, and social challenges, and practical guidelines for retrofitting older buildings. Public-private partnerships, integration into urban development strategies, and regulatory frameworks are crucial. Public awareness about environmental and social benefits is also important. Future research should focus on developing actionable solutions for retrofitting older buildings to modern standards, involving architects, engineers, and conservation experts.

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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 author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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