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Harnessing the Potential of Recycling Architecture for Sustainable Development

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Abstract

This article explores the transformative potential of recycling architecture in not just proposing recycle materials into building construction but also the integration of repurposing old buildings to address community needs within Malaysia's sustainable development framework. Amidst rapid urbanization and environmental concerns, recycling architecture offers a strategic avenue to alleviate resource scarcity and reduce environmental impact. Through an analysis of literature, case studies, and field observations, this study investigates the viability and benefits of repurposing old buildings to meet diverse community requirements. It examines how adaptive reuse, material recycling, and sustainable construction techniques can rejuvenate disused structures, serving as community hubs, educational facilities, or cultural spaces. Highlighting socio-economic and environmental advantages such as waste reduction, energy efficiency, and cultural preservation, repurposing old buildings fosters community revitalization and social cohesion. Despite regulatory and financial challenges, embracing recycling architecture presents opportunities for inclusive and sustainable community development. This research advocates for collaborative, culturally sensitive approaches in architectural design and urban planning to realize Malaysia's sustainable development goals. The article concludes with recommendations for policymakers, architects, developers, and communities to harness the potential of recycling architecture, emphasizing innovation and community engagement in repurposing old buildings for sustainable community development in Malaysia.

Keywords: Recycling Architecture, Sustainable Development, Adaptive Reuse, Material Recycling, Sustainable Construction

Introduction

According to (Kean Jie & Mohamed, 2023), In Malaysia, the rapid pace of urbanization has resulted in the abandonment and neglect of numerous historic buildings, posing a significant challenge to the preservation of the nation's architectural heritage. However, amidst these

challenges lies an opportunity for sustainable development through the repurposing of old buildings (Kean Jie & Mohamed, 2023). By applying principles of recycling architecture, these structures can be transformed into vibrant community spaces that meet the evolving needs of Malaysian society while preserving cultural identity (Kean Jie & Mohamed, 2023). This essay explores the potential of repurposing old buildings as a sustainable solution to address urbanization pressures and promote community well-being in Malaysia (Kean Jie & Mohamed, 2023).

Repurposing old buildings aligns with Malaysia's commitment to achieving sustainable development goals, particularly in the realms of urban sustainability and cultural preservation (Kean Jie & Mohamed, 2023). These structures, reflecting a blend of Malay, Chinese, Indian, and colonial influences, hold invaluable cultural significance that must be preserved amid rapid urban development (Kean Jie & Mohamed, 2023). Furthermore, repurposing old buildings offers an opportunity to address pressing community development needs, such as the creation of community centers, educational facilities, and cultural hubs. By breathing new life into these structures, Malaysia can foster social cohesion and enhance the quality of life for its citizens (Kean Jie & Mohamed, 2023).

In conclusion, repurposing old buildings represents a promising avenue for sustainable community development in Malaysia (Kean Jie & Mohamed, 2023). By leveraging recycling architecture principles, the nation can transform abandoned or underutilized structures into functional, environmentally friendly spaces that contribute to urban sustainability and cultural preservation (Vidyullatha et al., 2023). However, realizing this potential requires concerted efforts from policymakers, architects, developers, and communities to overcome regulatory barriers, secure funding, and engage in collaborative planning processes (Wergeland & Hognestad, 2021). Through collective action, Malaysia can unlock the transformative power of repurposing old buildings to create a more sustainable and inclusive built environment for future generations (Kean Jie & Mohamed, 2023).

Problem Statement

Motivational Problem

Despite Malaysia's rich architectural heritage and cultural diversity, many historic buildings across the country are facing neglect and abandonment due to rapid urbanization and modernization (Tan Bee Eu, 2024). These structures, representing a blend of Malay, Chinese, Indian, and colonial influences, are invaluable assets that contribute to the nation's identity and cultural legacy (Tan Bee Eu, 2024). However, as urban areas expand and development pressures increase, these buildings are often left to deteriorate, leading to the loss of architectural heritage and cultural identity (Devi, 2023).

This neglect of historic buildings raises a pressing concern regarding the preservation of Malaysia's cultural heritage and the sustainable development of its urban areas (Suratkon & Abdullah, 2020). Without intervention, these buildings risk being demolished or left to decay, resulting in the loss of irreplaceable cultural assets and architectural landmarks (Devi, 2023). Moreover, the failure to repurpose and revitalize these structures contributes to urban blight and diminishes the quality of life for communities living in proximity to these neglected sites (Devi, 2023).

Therefore, there is a critical need to address the challenge of repurposing old buildings for sustainable community development in Malaysia (Tan Bee Eu, 2024). By exploring innovative approaches and implementing recycling architecture principles, Malaysia can transform these neglected structures into vibrant community spaces that serve the needs of its diverse population while preserving its rich cultural heritage (Priya Devan, 2023). This motivation problem underscores the urgency of finding sustainable solutions to revitalize historic buildings and enhance the resilience and livability of Malaysia's urban areas.

Research Problem

As mentioned by (Wergeland & Hognestad, 2021), the potential of repurposing old buildings for sustainable community development. Despite the widespread architectural significance and cultural value of many historic buildings worldwide, numerous structures are left abandoned or underutilized, presenting challenges to both cultural preservation and urban sustainability (Šijaković, 2015). The research endeavors to investigate the feasibility and effectiveness of leveraging recycling architecture principles to breathe new life into neglected structures, transforming them into vibrant community spaces that address the evolving needs of diverse societies while promoting sustainable development (Hauke & Werner, 2012).

At the heart of this inquiry lie several pivotal questions. Firstly, what are the socio-economic, environmental, and cultural benefits associated with repurposing old buildings for community development (Vidyullatha et al., 2023)? Uncovering these multifaceted benefits is essential for assessing the overall value proposition of such endeavors (Vidyullatha et al., 2023). Furthermore, the study seeks to uncover the challenges and barriers inherent in repurposing old buildings and to propose actionable strategies for overcoming these obstacles (Zheng et al., 2022). Additionally, it aims to delve into stakeholders' perspectives on repurposing old buildings for sustainable community development, considering the varied viewpoints of policymakers, architects, developers, and local communities involved in such initiatives (Kuunifaa, 2021).

The study carries significant implications and holds the potential to offer valuable insights. From informing urban planning policies to guiding architectural design practices, the findings of this research can empower stakeholders worldwide to make informed decisions regarding the preservation and revitalization of historic buildings for sustainable community development (Hauke & Werner, 2012). Ultimately, the research endeavors to contribute to the collective efforts aimed at fostering resilient, inclusive, and culturally vibrant communities within the context of global urbanization and sustainability challenges.

The primary aim of this research is to explore the feasibility of repurposing old and abandoned buildings in Malaysia to meet community needs. Specifically, the study seeks to investigate the potential for recycling architecture as a sustainable strategy for addressing urban challenges. The objectives of this research are twofold: first, to examine the feasibility and effectiveness of community responses to repurposing abandoned buildings for community use; and second, to analyze case studies and real-world examples, both locally and internationally, of successful instances where old and abandoned buildings have been transformed to meet community needs.

The research questions driving this study are centered around the role of design in sustainable development. The study seeks to answer the following key questions: What design strategies can be employed to effectively repurpose old buildings for sustainable community development? How do design considerations influence the socio-economic, environmental, and cultural benefits of repurposing old buildings? Finally, how can design contribute to the creation of inclusive, culturally vibrant community spaces within repurposed buildings, while also aligning with sustainable development goals? These questions aim to uncover the broader implications of recycling architecture on community development.

Systematic Literature Review

The following systematic literature review provides an in-depth exploration of various studies focusing on the adaptive reuse and recycling of old and abandoned buildings for community and sustainable development. This review encompasses research on topics such as heritage preservation, environmental sustainability, architectural innovation, and the cultural significance of reusing buildings. Each study highlights a specific aspect of adaptive reuse, whether it is focused on energy efficiency, social impact, or cultural regeneration, and collectively, they offer insights into how buildings can be repurposed to meet contemporary community needs while preserving their historical and architectural value.

This literature review aims to shed light on the importance of adaptive reuse as a sustainable architectural strategy and its role in urban regeneration, community engagement, and environmental conservation. By examining case studies from various countries and contexts, the review illustrates the challenges and opportunities associated with recycling architecture. It also emphasizes the potential for repurposing buildings to address socio-economic and environmental challenges, aligning with sustainable development goals. The table below presents key studies and their contributions to this field, outlining their background, problem statements, gaps, methods, and conclusions.

Table 1
Systematic Literature Review

Document	**Background Study**	**Problem Statement**	**GAP**	**P.O.D**	**Method**	**Result**	**Conclusion**	**Contribution**	**Remarks**
Lucchi (2020) - Enhancing the historic public social housing through a user-	The study provides a comprehensive educational experience on the deep refurbishment and	The area is currently a multicultural hub, characterized by a fragile population, significant socio-spatial inequaliti	Reusing existing buildings is crucial for sustainability, as it prevents new land-uses and reduces	The focus is on the redevelopment of the San Siro neighborhood, the largest public social housin	The project involves historical research, neighborhood survey, on-site	Eight architectural design projects aim to upgrade social housing stock by combining	The socio-technical approach involves a thorough understanding of the area	The authors, including A.C.D. and E.L., contributed to the conceptualization, investigation, supervision,	This study explores the possibility of revitalizing old public social housi

centered design-driven approach	revitalization of the San Siro neighborhood in Milan, Italy.	es, and intercultural and intergenerational conflicts.	energy consumption associated with construction.	g area in Milan.	visits, hands-on training, architectural design practice, and on-site exposition.	social needs, architectural quality, environmental sustainability, energy efficiency, and human comfort.	and building, comparing historical and recent publications on various aspects such as morpho-typology, technology, environmental, economic, and social aspects.	methodology, draft preparation, review, editing, and visualization of the manuscript.	ng and to transform it to improve local lifestyle.
Florentina-Cristina (2014) - Conversion of Industrial Heritage as a Vector of Cultural Regeneration	This study aims to showcase the diverse and rich architectural expression of industrial buildings in Romania, highlighting their cultural value.	The perception of environmental protection has led to the redevelopment and renaissance of industrial areas in recent decades.	The cultural objective promotes sustainable re-use of redundant buildings in industrial and commercial heritage, promoting	This study explores the impact of culture on the fate of abandoned industrial buildings, while also highlighting its potenti	The study utilized case studies to showcase effective practices in culturally reusing Romanian industrial	Implementing these measures could ensure a continuous transformation of industrial enterprises into functional cultura	Conservation and capitalization of cultural resources indicate society's interest in culture. Romania's techni	The study was funded by the strategic grant POSDRU/107/1.5/80765, co-financed by the European Social Fund, under the Sectoral Operational	This study explores the industrial heritage buildings in Romania.

			positive reuse and enhancing the overall aesthetic appeal.	al to boost economic productivity.	heritage.	l objectives.	cal museums convert industrial sites into cultural tourist attractions, boosting declining economies.	Program Human Resources' Development 2007-2013.	
Ferriss (2021) - Sustainable reuse of post-war architecture through life cycle assessment	The mid-20th century saw architectural idealism, technological innovation, and construction growth, leading to less climate responsive buildings and increased energy efficiency.	Mid-century buildings, due to their significant contribution to global greenhouse gas emissions, must be effectively repurposed to meet climate goals while respecting their history.	The proposed solution challenges current heritage conservation practices and imposes upfront carbon costs that must be assessed against potential performance enhancements.	This study aimed to define a smart energy retrofit that minimizes total carbon emissions, including embodied and operational carbon reductions, in the critical near term.	This paper presents two case studies on the reuse of undergraduate residence halls, highlighting significant carbon savings and proposing an analysis-based methodology for optimi	The study of Ham and MacGregor Halls demonstrates that post-war buildings can significantly reduce carbon emissions through proper stewardship, airtight envelopes, and efficient	The case studies demonstrate the potential of reusing and retrofitting Post-War buildings as a climate solution, utilizing two methodologies for quantifying total carbon reductions.	Lori Ferriss, an architect, structural engineer, and conservator, is a leader in sustainable stewardship for the built environment. She promotes cultural and environmental sustainability through design and champio	This study studies post war architecture buildings and provide solutions for smart energy retrofit into it to reduce carbon emissions.

					zing targeted interventions.	systems.		ns for built heritage preservation, serving as Co-Chair of the Zero Net Carbon Collaboration.	
Šijaković (2015) - Recycling industrial architecture: the redefinition of the recycling principles in the context of sustainable architectural design	The article explores the concept of recycling at various levels of understanding, focusing on its perception in relation to architecture.	Recycling inspires architecture in various ways, including building materials, functions, structural elements, form, historicism, and energy recycling as recuperation.	Recycling encompasses adaptation, transformation, reuse, and return, including transforming a building, reusing concepts or ideas, and reusing linguistic, literary, or poetic media.	The text discusses inspiring architecture that utilizes recycling at various levels, thereby focusing on objectifying the ideological essence of the work.	The summary provides a concise overview of the work's results and essence, presenting a subjective evaluation of the issue.	Summers' definition of recycling in architecture emphasizes its importance at various levels, including material reuse, building reuse, and form and idea, for ecologically, culturally, and socially sustainable	This article explores the broader meaning of recycling in architecture, extending beyond the traditional technological process of processing waste into reusable construction materials.	Matúš Kiaček, a 1*1 alumni from Slovak University of Technology, is a professor in the Faculty of Architecture and Design at the Institute of Architecture of Residential Buildings.	This study approaches the different levels meaning of the word recycling in the perspectives of architecture designs

						architecture.			
Wergeland (2021) - Reusing stadiums for a greener future: The circular design potential of football architecture	Since the New Millennium, global efforts to build environmentally friendly sports arenas have surged, driven by major events like the 2000 Sydney Olympics and 2006 FIFA World Cup.	Older buildings are often considered less energy-efficient due to commercial interests and the idea of stadiums as urban generators. New stadiums may offer green performance potential, but older ones may not meet climate requirements.	Football stadium reuse in Europe is low, with 'heritage' referring to historical values, architectural, social, and sporting aspects, and 'circular' referring to the circular economy.	The objective is not only to evaluate the general lack of reuse but also to highlight green strategies that could extend the lifespan of existing stadiums.	The study analyzes Tyneca stle Park in Edinburgh and Stadio Flaminio in Rome, using sports science, preservation, architecture, and circular design theory to explain why older stadiums become obsolete.	The study suggests that football architecture can be reused and circularly managed, based on insights from Tyneca stle Park and Stadio Flaminio.	The future of historical stadiums and circular design potential in football architecture depends on the sports world's commitment to better care for its architectural legacy.	The authors listed have significantly contributed to the work and have approved it for publication.	This study explores the option whether we really need new stadiums to host world sport events or we can retrofit and uses the old stadiums

Kuunifaa (2021) - Sustainability and Reusing Buildings for Libraries: A Review of Selected Documents	The LIS profession is promoting adaptive reuse of old buildings for new libraries, promoting sustainability by conserving natural resources and minimizing the need for new materials.	Building reuse is gaining popularity in developed countries, while some developing nations face challenges in implementing this trend.	Over time, structures will deteriorate and lose their original functionality and usefulness.	Building reuse offers a chance for sustainable library planning, promoting greener practices and adaptive reuse, as greener architecture and design are already evident in library architecture and design.	This qualitative research method evaluates printed and electronic documents, including journal articles, conference proceedings, and books, to enhance understanding of libraries and sustainability issues.	This document analysis presents a robust argument for sustainability based on its findings and observations.	The current period presents a critical opportunity for sustainable development in libraries and communities, as they can greatly benefit from adapting and reusing buildings.	The authors collaborated on conceptualization, methodology, software, validation, investigation, data curation, writing, initial draft preparation, review, editing, and supervision, ensuring all authors read and agreed to the published manuscript.	This study shows retrofitting an old industrial building and reuse it into a library to give back to the community
Zheng (2022) - From Maslow to Architectural Spaces: The Assessment of Reusin	Urban renewal often discards older structures, such as obsolete industrial buildings, without	Reusing old industrial buildings for public service is often a challenge, as converting unfamiliar buildings	This paper examines if Abraham Maslow's Hierarchy of Needs, a psychological	The paper applies this concept to the field of architecture, proposing an assessment frame	The assessment framework uses Shanghai 1933 Old Millfun, China as a	The 1933 Old Millfun building's basic needs are high quality, challenging	The research simplifies subjective project success and failure judgments into	The authors express gratitude to the Greater Visakhapatnam Municipal Corporation for their support	This study shows assessing the possibilities of reusing old indus

g Old Industrial Buildings	considering their future potential in urban areas.	into civic spaces can be challenging.	theory, can be applied to the reuse of former industrial buildings, considering individual needs.	work for evaluating the reuse of old industrial buildings.	case study, combining mathematical models for quantitative evaluation of completed projects and identifying challenges for future development.	needs drive uniqueness, advanced needs are neglected, and the evaluation's issues guide future development, ensuring a well-placed approach.	multiple factors and analyzes them quantitatively.	in conducting case studies on retrofitted buildings and obtaining permissions to use a conservation report.	trial buildings to serve to the public
Vidyullatha (2023) - Adaptive Reuse of Heritage Buildings for Sustainable Urban Regeneration: Two Case Studies from India.	Globalization has led to the development of smart cities, enhancing citizens' quality of life, as a strategy in many countries.	Traditional settlements and cultural heritage are being demolished without respecting their values, despite the potential for easy reuse of these heritage buildings.	A proper approach is crucial for ensuring relevance in urban regeneration projects, as cultural heritage should be preserved with its values.	This paper explores adaptive reuse challenges, emphasizes informed decisions, and highlights stakeholder involvement in successful project	The study uses a mixed-method approach, including case studies, stakeholder surveys, and heritage building analyses, to explore the	Adaptive reuse transforms buildings, reducing demolition due to demand and limited land availability. Most buildings can serve for 30-50 years	Adaptive reuse is a sustainable urban regeneration method, but it requires thorough research and respect for the heritage it aims to	To ensure the highest level of transparency in the Ministry of Finance and Economic Development (Malaysia) through the implementation of the TAP-K015205	This study explores 2 case studies from india about reusing old heritage buildings for sustainable urban revival

				s, focusing on preserving heritage structures' physical and historical integrity.	benefits of reusing old buildings.	post-repairs, fulfilling contemporary building requirements.	rejuvenate.	, the Malaysian Government (UKM) has implemented the following measures.	
Kean Jie (2023) - Adaptive Reuse and sustainability of Heritage Shop House in Historical Cities in Malaysia	Malacca's rich history and architecture, including its heritage shop houses, have earned it UNESCO's World Heritage Site recognition.	Scholars emphasize adaptive reuse as a conservation method, preserving old buildings while incorporating contemporary functions that align with modern society.	Heritage shop houses in cities can continue to thrive despite evolving socio-cultural and economic needs, ensuring relevance and survival.	This research explores sustainable design strategies for heritage shophouses and the adaptive reuse process of shophouses in Jonker Street that have undergone this process.	This research uses literature reviews, observation, and personal interviews to study shophouses and explores adaptive reuse as a conservation model for sustainability and cultural preservation.	The initial revenue for sustainable design approaches in heritage store houses is below, but further studies are needed to validate these approaches.	The sustainability of the current recycled store houses can be improved for long-term development while preserving local heritage.	Conceptualization, M.P. and B.W.; methodology, M.P.; formal analysis, M.P. and B.W.; investigation and resources, M.P.; writing—review and editing, M.P. and B.W. All authors have read and agreed to the published version of the manuscript.	This study explores the revival of heritage shop houses in historical cities of malaysia

Pieczka (2021) - Art in post-industrial facilities—strategies of adaptive reuse for art exhibition function in Poland	Sustainable industrial reusing processes are underway, with potential adaptations to cultural-related goals, a tradition in the world.	Post-1989 socio-economic changes in Poland and the start of industrial restructuring led to the loss of original purpose of many industrial architecture objects.	This text uses the terms "adaptive reuse" and "recycling" interchangeably, and will treat them as such in this context.	The article examines the repurposement of post-industrial facilities in Poland for art exhibitions, including museums, galleries, and art centers.	The study utilized descriptive qualitative and quantitative research to identify and analyze adapted objects, develop a typology of adaptive reuse strategies, and conduct questionnaire research on institutions in adapted facilities.	The analysis reveals that former power plants are the primary adapted facilities in Poland, offering favorable exhibition conditions through five types of adaptive reuse strategies, involving object extension, exhibition placement, space character, and interior intervention.	The paper presents a typology of adaptive reuse strategies based on main criteria, enabling the acquisition of art exhibition space in former industrial facilities.		This study explores the retrofitting of post industrial facilities and the strategies to adapting it into an art exhibition in poland

Design Strategies for Adaptive Reuse of Heritage Buildings in Sustainable Urban Development

The adaptive reuse of old heritage buildings for community-centric projects has become a significant trend in sustainable urban development. This approach not only preserves architectural and cultural heritage but also revitalizes these structures to serve contemporary community needs. By integrating theoretical frameworks from various fields, this process ensures the sustainable transformation of heritage buildings into vibrant community hubs. Four pivotal frameworks guide the adaptive reuse of heritage buildings into community-centric projects.

The framework of modular adaptation, inspired by Chen's (2018), Modular Apparel Safety Architecture (MASA), can be applied to heritage buildings. This framework decomposes the transformation process into modular phases, ensuring each phase adheres to safety and preservation standards. By segmenting the renovation process into discrete modules—such as structural reinforcement, interior redesign, and community space integration—this approach guarantees efficient and safe adaptation of heritage buildings. Modular adaptation allows for phased redevelopment, minimizing community disruptions while preserving the historical integrity of the buildings and incorporating modern amenities (Chen, 2018).

Building on Fenici's (2019), DIY Design for Disassembly Framework, the lifecycle extension framework emphasizes adaptive reuse to prolong the functional life of heritage buildings. This approach transitions heritage buildings from their original purposes to new, community-focused uses, ensuring ongoing relevance and utility. By designing for adaptability and future modifications, this framework facilitates repurposing spaces to meet evolving community needs. This also aligns with principles of the circular economy by maximizing existing structures, thereby reducing demand for new construction and preserving cultural heritage (Fenici, 2019).

Conceptual Framework

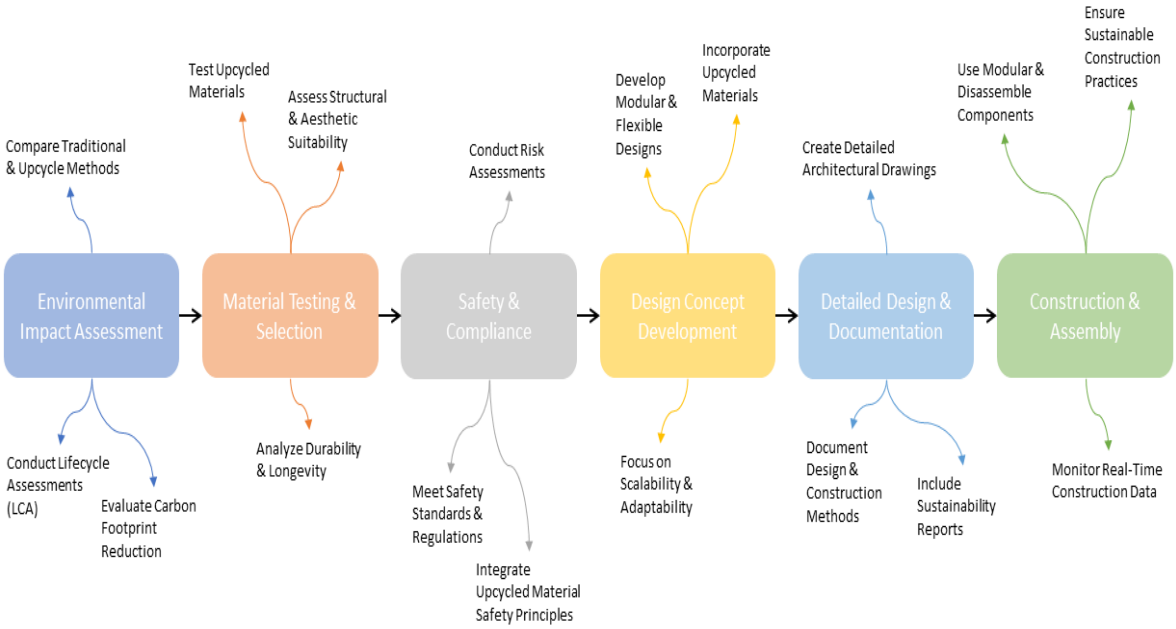

Figure 1: Conceptual Framework

The first stage in the adaptive reuse process involves conducting an Environmental Impact Assessment (EIA). This step compares traditional construction methods with upcycled approaches to determine the most environmentally sustainable option. It includes performing Lifecycle Assessments (LCA) and evaluating the potential for reducing the carbon footprint. Through this analysis, project planners ensure that the transformation of heritage buildings is aligned with environmental sustainability goals, setting a solid foundation for informed decision-making throughout the project (Chen, 2018).

Safety and regulatory compliance are critical in the adaptive reuse of heritage buildings. At this stage, risk assessments are conducted to identify potential hazards, ensuring that all safety standards and building regulations are strictly followed. Integrating principles for the safe use of upcycled materials is also key. By adhering to these regulations, the project guarantees the safety of future occupants while maintaining the structural integrity of the building. Compliance with these standards is non-negotiable, forming a secure basis for the next phases of the project (Fenici, 2019).

Once safety and material considerations are addressed, the focus shifts to design concept development. This phase emphasizes creating modular and flexible designs that incorporate upcycled materials. The design must be scalable and adaptable to meet the evolving needs of the community. Architects, at this stage, develop innovative design concepts that breathe new life into heritage buildings, ensuring functionality while preserving their historical significance. This is a crucial step for aligning the project with modern requirements while honoring the building's heritage (Weng, 2021).

The final stage is the construction and assembly phase, where the actual transformation occurs. Sustainable construction practices are emphasized, including the use of modular and disassemblable components. Real-time monitoring of construction data ensures that the project remains aligned with sustainability objectives. This phase integrates all previous assessments, designs, and compliance measures, ensuring the successful adaptation of the heritage building into a functional, sustainable community space. Sustainable practices during construction ensure the long-term environmental and operational viability of the project (Zheng, 2022).

Conclusion

Repurposing old buildings through innovative design strategies offers a promising solution for sustainable community development. By addressing the socio-economic, environmental, and cultural benefits, this approach not only preserves architectural heritage but also revitalizes urban areas, creating inclusive and vibrant community spaces. Despite facing challenges such as regulatory constraints, funding limitations, and cultural sensitivities, effective design solutions can overcome these obstacles, ensuring the successful transformation of neglected structures.

Stakeholder perceptions underscore the importance of collaboration among policymakers, architects, developers, and local communities. Their collective efforts are essential in fostering a shared vision and implementing practical strategies for repurposing old buildings. The potential implications of such initiatives extend beyond immediate urban landscapes, contributing significantly to the broader goals of sustainable development and cultural preservation. The research suggests a shift in architectural and urban planning practices, emphasizing design's role in creating resilient communities and repurposing old buildings for a sustainable future.

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