

STRATEGIES OF INFILL ARCHITECTURE FOR REVITALIZING URBAN SPACES EFFECTIVELY

Ar. MARIA CRISELDA SORIANO, JAIRA ABYGAIL BULONG, MARC GERALD CRISTOBAL, NAJA MAE NORREN DALLEG, CHRISTIENNE JANE ETRATA, MCROENTGEN ALFRED LIQUIT, KATHLEEN PEARL NUESCA, YRAISAH RAULA PASCUA, JONALYN REGALA, JAYSA MAE VALDEZ

Department of Architecture
Saint Louis University
Baguio City, Philippines

Abstract— Infill development solves urban sprawl by optimizing space and improving urban environments. It maximizes land use by developing underutilized sites, creating new community growth, and promoting sustainability. This study investigates the challenges of urbanization in Philippine cities, where rapid growth has resulted in urban sprawl, environmental degradation, and strained infrastructure. It examines infill development as a strategic solution, focusing on revitalizing underutilized urban spaces to promote sustainable, compact, and connected growth. The study analyzed the literature on infill development, architecture, and site characteristics. It identified infill sites based on urban context, economic conditions, land use, and design considerations. Strategies for infill architecture were identified based on Key Success Factors (KSF) and relevant guidelines. This research evaluates infill architecture case studies in urban areas facing growth problems. It categorizes infill sites into brownfield, greyfield, greenfield, and sub-categories like gapsite and backland. Infill solutions are specific to their problem and context, but there is a notable association with sustainability and green building techniques. Green building techniques apply to almost any situation and should integrate well into the context. Community engagement and compatibility are also crucial for successful infill projects. The study supports the need for thorough strategic planning and innovative design to optimize underutilized land in infill development and revitalize urban spaces effectively.

Keywords— Infill development, urban environment, sustainable urban growth

I. INTRODUCTION

Infill development is a potential solution to containing urban sprawl and its related issues (Schiller et al., 2022; Abedini & Khalili, 2019). Urban infill development, a concept that gained prominence in the 1980s for optimizing space and improving urban environments (Rahmat et al., 2022), maximizes urban land use by developing underutilized city sites, creating new growth in existing communities (AlHasawi et al., 2024) and promoting sustainability by reducing the need for expansion into undeveloped areas (Abd-Elkawy, 2023). This characteristic of revitalization and reuse makes infill development a key component of smart growth (Laine et al., 2018; AlHasawi et al., 2024), particularly its principles on compact development and preservation of open spaces (U.S. EPA, 2011). Smart growth also prioritizes fair, cost-effective development, enhances community engagement, and supports

unique, attractive communities with a strong sense of place (U.S. EPA et al., 2014; Mohammed et al., 2016). Part of its principles encourages the strengthening and development of existing areas such as central cities and inner suburbs while limiting growth in rural and undeveloped areas (Sree et al., 2020; Heberle & Kackar, 2006), making infill sites vital urban development areas for smart growth strategies.

However, for infill strategies to succeed, they need the support of a master plan or comprehensive plan establishing its policy basis and clear objectives for the desired outcome of the infill project (Khadour et al., 2023; MDP, 2001). Infill development also faces multiple challenges. Physical impediments such as restricted areas, site preparation, and old infrastructure raise expenses and complicate design (Aly & Attwa, 2013; Shamarti & Haitham, 2020; QC Ordinance, 2016; Reynolds, 2015; Austin, 2014; MDP, 2001). There are also regulatory hurdles, such as restrictive zoning regulations, lengthy permission processes, and stringent environmental assessments (Elkawy, 2023; Abedini & Khalil, 2019; QC Ordinance, 2017; MDP, 2001). Economic obstacles like high land costs, difficulties obtaining funding, and fragmented land ownership render many projects financially impossible (Shamarti & Shammari, 2020; Reynolds, 2015; Aly & Attwa, 2013; MDP, 2001). Furthermore, administrative inefficiencies and political resistance contribute to delays and higher costs (Reynolds, 2015; Wang, 2019). Cities that have adopted infill strategies, such as Quezon City, have managed to mitigate these growth-related challenges by transforming vacant land into mixed-use developments to enhance urban density and reduce sprawl. The increasing utilization of formerly unoccupied land is another trend in the development of commercial areas (CLUP, 2011-2025). Baguio City has already created a general land use proposal for existing residential areas that will be "infilled" to meet the population's requirement for shelter (CLUP, 2013-2023). This comparison underscores the importance of smart growth planning and adopting effective land-use strategies in addressing the myriad growth-related challenges faced by various cities (Litman, 2015). Infill development goes beyond simply occupying or repurposing spaces. Approaches for infill are typically based on one or more of the following targets:

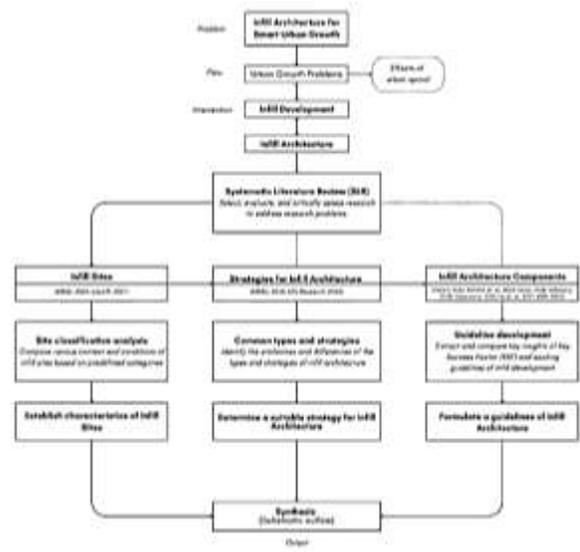
transportation, air and water quality, access to daily needs and services, and affordable housing supply (Winig et al., 2014).

Existing guidelines for infill architecture place significant importance on architectural contextuality, also referred to as compatibility (MDP, 2001), as in how new architecture can fit in with the existing context. Contextuality is often a problem in designing urban areas due to being an approach that considers and responds to the situation and conditions of a specific location (Rahmat et al., 2022). Contextuality emphasizes the ability of a building to seamlessly blend with its environment (Gaber & Akçay, 2020), achieved through either “mimesis,” imitating visual effects and neighboring object characteristics, or “association,” projecting the characteristics of the surrounding design (Rahmat et al., 2022). While it is also valid to ultimately create a new image by using the “contrast” method—denying part or all the characteristics of the surrounding environment (Rahmat et al., 2022); infill architecture must have some degree of compatible architectural character with its context (Alitany, 2019), which involves its external characteristics prevailing in the formation of building facades, such as height, scale, proportions, formation, details, building materials, texture, colors, porosity, proportions of openings, and vertical and horizontal rhythms (Abbas, 2023). This compatibility improves the urban image by enhancing the existing visual character and identity of the chosen development area, which is in line with one of the key success factors for the application of infill projects (AlHasawi et al., 2024).

The problem is that existing theoretical models for infill development approaches are incomplete and must be challenged and further refined (Kousunen & Atkova, 2019). Understanding residual spaces (gap sites) and urban voids (abandoned buildings) is crucial for effective community development and urban planning; however, there is a gap in local case studies exploring the reclamation of neglected and vacant areas. For example, requalifying vacant buildings is one avenue for infill architecture, but strategies must be developed to manage potential negative impacts while maximizing benefits (Santos & Ramalhet, 2024). There is currently no widely accepted methodology for integrating new architectural elements into diverse urban settings, which can hinder the potential of infill projects (Alfirevic, 2015).

Therefore, this research aims to develop an approach for infill architecture case studies in cities with growth problems based on the principles of infill development and components of its architecture. To create a methodology for infill architecture, the research studied the following aspects of infill development and architecture using the following objectives: (1) To establish the characteristics of infill sites in urban areas experiencing growth problems; (2) To determine a suitable strategy for infill architecture according to the different types of infill development, and; (3) To determine the components of infill architecture according to Key Success Factors (KSF) and existing design guidelines for infill development.

Figure 1
Conceptual Framework



The conceptual framework positions infill architecture as a strategic response to urban sprawl. This framework narrows the focus of infill development specifically to infill architecture, leading to the establishment of three primary categories: (1) characteristics of infill sites, (2) strategies of infill architecture, and (3) components of infill architecture. The first objective is to identify potential infill sites through site classification analysis. The framework is based on theoretical readings, which heavily rely on existing literature to categorize the concepts involved in infill development and architecture. It also established the three primary categories, as shown in Figure 1. Ultimately, this conceptual framework seeks to explain the characteristics of infill architecture, determine a suitable strategy, and create actionable guidelines to facilitate an infill architecture case study.

II. METHODS

This study used a qualitative strategy involving a comprehensive review and content analysis of related literature. The review was accomplished by first creating a repository of related literature using search engines for research and academic databases such as Google Scholar, JSTOR, Elsevier, Science Direct, Research Gate, etc. The related literature must be research journals, government publications, or books published within the range of 2014 to 2024, containing the keywords: infill development, infill architecture, characteristics of infill sites, infill development and architecture guidelines; and Comprehensive Land-Use Plans (CLUP) of Philippine cities facing urban growth problems. However, additional materials not included in the repository due to earlier publication dates may be considered when the materials are too limited, and the contents of earlier published material are highly significant in relation with the research objectives.

Following this procedure, roughly 200 related literature and 10 CLUPs were compiled. The compiled literature was then reviewed by creating an overview summarizing each related literature's problems, objectives, and methods to identify the relevant related literature. Out of the 200 related literature, 84 were found to be appropriate, with only two out of ten CLUPs, Baguio and Quezon City, mentioning infill in their contents, and San Fernando City having smart-growth aligned goals in their vision and mission. Information addressing each objective will be extracted using this repository of relevant related literature, as well as new related literature that may be added to the repository as required by the objectives of the research as it progresses. A frequency analysis was conducted to determine the desired output for each respective objective that includes the following: characteristics of infill sites, a methodology for infill architecture, and guidelines for infill architecture.

To establish the characteristics of infill sites, a review of existing case studies and research journals was conducted to distinguish different characteristics associated with infill sites, comparing various contexts and conditions of infill sites into predefined categories as a form of site classification analysis. The findings of this analysis were organized into a categorical presentation, where identified characteristics were sorted according to (7) predefined categories of infill sites, which include the following: (1) urban context, (2) economic and social condition, (3) land use and function, (4) site exposure and accessibility, (5) environmental quality, (6) spatial characteristics, and (7) design considerations. The elements within each category were ranked based on their priority and then translated into percentage scores to reflect their relative importance. The scoring system provides a clear overview of the significance of each element, which serves as the foundation for developing an infill site evaluation criterion for later site selection.

Determining a suitable strategy for infill architecture involved analyzing strategies and approaches for different infill projects by reviewing various case studies and research journals on examples of existing or proposed infill projects, specifically focusing on the types of infill development and the strategies employed. The frequency of the identified types and strategies was counted to identify the most employed types and strategies of infill architecture.

To determine the components of infill architecture, Key Success Factors (KSF) were identified by reviewing existing case studies and research journals on infill development projects and presented in the form of a tabulated list, citing KSFs and source (Title, Author, Year). Existing guidelines from research journals and government publications were compiled and summarized, with their relevant sections identified. In the context of this study, "relevant sections" refer to sections of the published guidelines concerned with any of the variables listed under the guidelines section of the theoretical framework diagram. These variables are structure, finishing, shape, style, pattern, height, open space, orientation,

zoning, color, size, proportion, visual quality, compatibility, and community needs. This information was organized and presented in table form, which displays the guidelines' origin, year of publication, and a short description of its relevant sections.

III. RESULTS AND DISCUSSION

This section presents the results and discussion aimed at addressing the following objectives: (1) to establish the characteristics of infill sites, (2) to determine a suitable strategy for infill architecture according to types of infill architecture and strategies for infill development, and (3) to determine the components of infill architecture according to KSFs and existing guidelines for infill development. The analysis synthesizes data gathered from existing case studies, research journals, and government publications to provide a comprehensive overview of the attributes that define infill and key design considerations for infill architecture.

Characteristics of Infill Sites

Infill sites can be effectively categorized into three primary types—brownfield, greyfield, and greenfield, each of which plays a crucial role in urban development (Newton, 2022). Within these categories, specific sub-categories, such as gapsite and backland infill plots, highlight the diverse opportunities and challenges associated with optimizing land use on the site. As Brunet et al. (2020) defined, infill plots are small parcels of vacant or underused land within built-up urban areas. These plots can be developed to optimize land use without expanding the urban footprint, thereby contributing to sustainable urban growth. Infill sites, on the other hand, refer to broader areas that include not only vacant lots but also abandoned or underused properties that can be repurposed for new construction (Ehrhardt et al., 2023). The following paragraphs summarize the findings for each predefined category by highlighting the key descriptions used to characterize the different infill sites and plots as determined from the comprehensive review of 30 related studies.

The leading significant finding is that brownfield sites are polluted lands that exhibit a high degree of contamination, which poses substantial challenges for redevelopment and public health (He et al., 2024; Mehdipour et al., 2024; Wan et al., 2024; Mohammed et al., 2022; Oliver, 2005). Brownfield sites can be defined on a spectrum of usage, with the second leading characteristic being underused properties, followed by abandonment or dereliction. These areas have industrial ruins, marking them as remnants of past economic activities in developed urban areas.

In the case of greyfield sites, they are identified as failed community shopping centers, which are often accompanied by extensive parking lots. These greyfield sites are also frequently surrounded by outdated residential tracts in inner and middle suburbs. The challenges associated with these areas are

primarily attributed to economic factors, as greyfields are categorized as economically outdated, failing, or under-capitalized, encompassing both commercial and residential that no longer meet current market demands (Dong et al., 2024; Madigan, 2023; Alli, 2018). The prevalence of small-scale developments is also highlighted. Contrary to brownfield sites, another significant characteristic of greyfield sites is that they are low in the degree of contamination (Vos, 2024; Duhr et al., 2023; Tureckova, 2021). However, the site may still possess physical traits detrimental to the quality of life (Herczeg, 2014).

Greenfield sites are defined as undeveloped areas, along with the term unexploited. These sites are previously zoned rural-agricultural land located in low-density urban areas. Greenfield sites can often be seen in the fringe of existing built areas, which typically include transitional zones that may feature a mix of residential, commercial, and other undeveloped lands (Jansson, 2023; Clayton et al., 2022; Newton et al., 2022; Glumac & Decoville, 2020; Zapata-Diomedes et al., 2019; Lewyn, 2015).

For gap sites, it is indicated that many are positioned to face the street directly (street frontage). This prominent feature enhances their visibility and accessibility. The second-ranking characteristic is that gap sites often have lots between existing properties. This positioning allows them to fill in spaces within established urban fabric effectively. Established access to streets is a significant feature enhancing these sites' usability. A notable portion of gap sites serves commercial purposes. Many gap sites are found in areas already urbanized.

The highest-ranking characteristic of backland sites is that they are primarily located behind existing buildings or rear lots. These areas are gardens or open spaces. Many backland sites lack direct street frontage and visibility, often of landlocked status. Most backland sites are commercial zones and areas used for garage courts and small commercial courtyards.

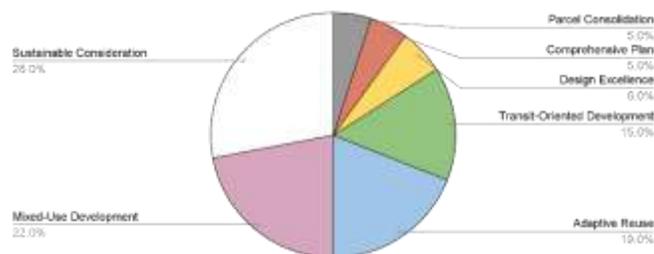
Strategies for Infill Architecture

Forty case studies were examined to determine the most common types and strategies of infill development. The identified types of infill development included adaptive reuse, mixed-use development, transit-oriented development, comprehensive plan, sustainable consideration, design excellence, and parcel consolidation. These infill projects utilized various strategies, including zoning compliance, community involvement, cost efficiency, integration of uses, green building practices, incentives, and vertical development.

Of the 40 case studies, Asia had the most variation in types of infill architecture, with a relatively smooth distribution between mixed-use development, sustainable consideration, and transit-oriented development. Europe has consistent marks for comprehensive plans and adaptive reuse types, indicating a focus on preserving existing structures and compliance with the implemented zoning of a specific location, given the age of most European towns. On the other hand, North America shows a notable emphasis on sustainable practices and transit-oriented

development, signifying a balanced approach that integrates modernization with environmental considerations. Infill development strategies with the most checkmarks in North America are community engagement and addressing barriers to development. Asia has many projects and strategies that involve the implementation of sustainable practices. At the same time, Europe blends strategic application with an emphasis on green building approaches and community engagement. Lastly, Australia and Africa have few case studies, but they strategically emphasize zoning compliance and cost efficiency. These case studies show that different cultures may adopt similar strategies for their unique urban problems. The following figures show the distribution of architectural types used in the identified successful infill projects and the most-used strategies for infill development, outlining the various key approaches for infill development.

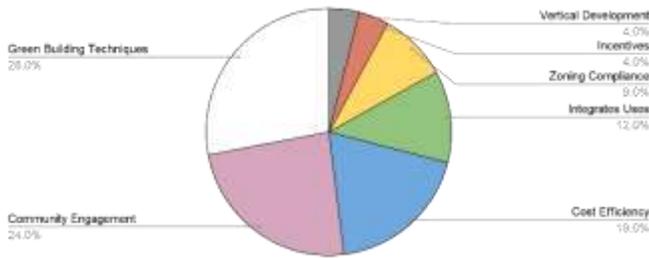
Figure 2
Types of Infill Architecture



Among the successful infill architecture projects, the most prominent type emphasizes sustainable considerations, followed closely by mixed-use development, adaptive reuse, and transit-oriented development (TOD). Sustainable considerations focus on using sustainable materials, energy-efficient designs, and resource conservation, highlighting the importance of environmentally responsible practices in infill construction (Tabrizi, 2019). Mixed-use development promotes sociability and walkability by integrating various activities within a single area or building (Rahmat et al., 2022), aligning with urban densification goals. Adaptive reuse involves repurposing existing structures instead of constructing new ones, which conserves resources and reduces waste (Rahmat et al., 2022). TOD aims to enhance accessibility, decrease car dependency, and lower carbon footprints.

On the other hand, the least common types of infill development among the reviewed case studies are design excellence –high standards in architectural quality (Rahmat et al., 2022); comprehensive plan – projects developed within the framework of a larger city or regional strategy (Korsunsky, 2019); and parcel consolidation –merging smaller lots to create larger, more usable spaces for development (Byahut et al., 2020). These types are more concerned with strategic methods of making the most of infill architecture through regulations and design goals.

Figure 3
Strategies for Infill Development



The most used strategy for infill development is the green building technique, which emphasizes sustainable design practices such as energy efficiency and using sustainable materials (Tabrizi, 2019). Following this, community engagement is crucial for involving local citizens and stakeholders to ensure that initiatives align with community needs and gain support (Austin, 2024). Cost efficiency also plays a significant role, focusing on economically viable solutions that maintain quality through smart budgeting and material optimization (Korsunsky, 2019). In contrast, integrated uses—promoting mixed-use spaces to optimize utility and address various community needs—ranks fourth in importance (Byahut et al., 2020). Zoning compliance, vertical development, and incentives are among the least utilized strategies for infill development, primarily due to regulatory barriers such as restrictive zoning laws. These laws often hinder the economic viability of infill projects, particularly when site conditions present challenges. If compliance with these regulations proves too difficult, infill development projects may fail to materialize (Abedini & Khalil, 2019; MDP, 2001).

Components of Infill Architecture

Key Success Factors (KSFs) of Infill Development

Eighteen related literatures were reviewed to identify and define the different KSFs. AlHasawi et al. (2024) describe KSFs as providing a theoretical and conceptual foundation for determining the direction of infill development by defining requirements. Central to these factors is community engagement, which involves actively involving stakeholders and educating the public during the planning process, fostering trust and strengthening social cohesion within neighborhoods. Following in rank, visual compatibility and community identity emphasize the importance of new developments harmonizing with the existing architectural character and cultural values. This alignment not only preserves the uniqueness of neighborhoods but also enhances the overall aesthetic appeal, making infill projects more acceptable to current residents.

The KSFs extend beyond community aspects to encompass design, functionality, and sustainability. For instance, literature stresses the significance of creating developments that functionally fit into their surroundings and establish strong

physical connections to encourage social interaction (Elshater et al., 2023). Energy efficiency is another critical factor that underscores the value of incorporating sustainable practices, such as solar technology and water conservation systems, into design concepts. This focus on sustainability is increasingly important in combating climate change and promoting responsible resource management. Additionally, ensuring inclusive access to public amenities and green spaces is essential for maintaining a diverse and vibrant community while preventing gentrification. By synthesizing and implementing these KSFs, infill development projects can significantly enhance community acceptance, operational effectiveness, and overall environmental sustainability, which is vital in shaping resilient urban landscapes.

Table 1
Summary of Key Success Factors

Key Success Factors	Authors ^{See Sources}	Total	Percentage	Rank	
SOCIAL ASPECTS					
1	Diversity	d, f, g, h, k, p	6	35.29%	4
2	Sense of Place	p	1	5.56%	24
3	Political Framework	b, c, e, m, p	5	27.78%	5
4	Community Engagement	a, b, d, f, g, h, j, k, m, n, p, q	12	66.67%	1
5	Connectivity & Inclusivity	f, g, j	3	16.67%	9
DESIGN ASPECTS					
6	Compatibility	f, h, i, k, l, n, o, p	8	44.44%	3
7	Identity	d, f, g, I, k, l, m, o, p	9	50.00%	2
8	Zoning Regulation	a, b, p	3	16.67%	9
9	Urban Design Codes	b, l, q	3	16.67%	9
10	Public Realm	h, p	2	11.11%	15
11	Adaptive Reuse	b, e, f	3	16.67%	9
USAGE & ACTIVITY ASPECTS					
12	Adaptability	e, g, h, p	4	22.22%	9
13	Landscape Connectivity	e, k	2	11.11%	15
14	Public Amenities	f, k, n, p	4	22.22%	8
15	Vitality	c, o	2	11.11%	15
16	Well-Integrated Function	e, g, h, k, n, o	6	33.33%	5
17	Comprehensive Plan	a, m	2	11.11%	15
ACCESS & LINKAGE ASPECTS					
18	Parking	g, p	2	11.11%	15
19	Integration	a, e, h	3	16.67%	9
20	Walkability	e, p	2	11.11%	15
21	Connectivity & Inclusivity	f	1	5.56%	24
22	Accessibility	e, o	2	11.11%	15
23	Public Transportation	e, o	2	11.11%	15
24	Renewal of Infrastructure	b	1	5.56%	24
ENERGY EFFICIENCY					
25	Improvement of Energy Efficiency	e, f, k, l, m, n	6	33.33%	5
26	Stormwater Management	e, f	2	11.11%	15
27	Waste Management & Waste Reduction	g	1	5.56%	24

Sources: ^aMDP, 2001; ^bAustin, 2014; ^cMomeni & Keyhanfar, 2016; ^dBeiglu et al., 2019; ^eJong, 2019; ^fTabrizi, 2019; ^gKorsunsky, 2019; ^hAlShamarti & AlShammani, 2020; ⁱAlAbide et al., 2020; ^jFerrick, 2022; ^kAbd Elkawy, 2023; ^lAbbas, 2024; ^mAlHasawi, 2024; ⁿAlHasawi, 2018; ^oElshater et al., 2022; ^pAly & Attwa, 2013; ^qGreater London Authority, 2022.

Guidelines for Infill Development

Infill development guidelines emphasize the critical role of thoughtful design that aligns with local contexts, ensuring new projects resonate with existing urban environments. 17 related literatures were reviewed for their content related to infill

architecture guidelines. The findings indicate that material finishing is paramount.

Table 2
Summary of Guidelines

Guidelines	Authors <small>See Sources</small>	Total	Percentage	Rank	
MATERIALS					
1	Structure	a, b, c, d, e, f, g, h, n, o, p, r	12	66.67%	2
2	Finishing	a, b, c, d, e, f, g, h, k, n, o, q, r	13	72.22%	1
FORM & SCALE					
3	Shape	c, e, f, i, k, n, p, q	8	44.44%	11
4	Style	c, d, f, g, h, i, j, n, q, r	10	55.56%	5
5	Pattern of blocks, road & surrounding	b, f, h, i, l, n, q	7	38.89%	13
6	Height	a, b, c, f, g, i, m, n, o, p, q	11	61.11%	5
PLACE & POSITION					
7	Mass pattern	b, c, e, f, h, i, l, n	8	44.44%	5
8	Open space	a, c, g, h, i, l	7	38.89%	13
9	Orientation based on surrounding structures	b, c, e, f, g, i, j, k, l, o, q, r	12	66.67%	2
USAGE					
10	Zoning & regulatory consideration	a, b, d, l	4	22.22%	17
11	Facilities & utilities	a, c, e, f, g, h, m, r	8	44.44%	11
12	Parking	a, h, j, l, o, q	6	33.33%	15
CONTEXTUALITY					
13	Color	f, p	2	11.11%	8
14	Size	b, i, k, p, r	5	27.78%	16
15	Ratio & proportion	i, j, n	3	16.67%	19
16	Visual quality	a, d, g, h, i, l, m, p, r	9	50.00%	8
17	Landscaping	h, l, m, q	4	22.22%	17
18	Topography	h, l, o	3	16.67%	19
19	Compatibility of urban environment	a, c, d, e, h, m, n, p, r	9	50.00%	8
COMMUNITY ENGAGEMENT					
20	Community Needs & Priorities	a, c, e, g, h, i, k, l, m, o, q, r	12	66.67%	2

SOURCES: ^aMDP, 2001; ^bOstanevics, 2017; ^cAlHasany, 2018; ^dFeisal, 2019; ^eAlAbide et al, 2020; ^fRahmat et al., 2022; ^gChabot, 2021; ^hQC Ordinance, 2016; ⁱOregon TGMP, 1999; ^jPCPPWD, 2021; ^kNew Hampshire, 2024; ^lPortland, 2008; ^mGAWA, 2024; ⁿCity of Georgetown, 2013; ^oSree et al., 2020; ^pSoemardiono, 2016; ^qGLA, 2022; ^rSwansea, 2014.

This focus on quality and compatibility of materials suggests that successful infill projects enhance visual coherence and respect the architectural character of surrounding buildings. A tie for second place among structure, orientation, and community needs highlights the integral relationship between new developments and their immediate environments. This awareness is particularly salient regarding building orientation, which must consider surrounding structures to maintain spatial harmony.

Next are height and form, reflecting an increasing recognition among architects and planners of the importance of proportionate designs that adhere to the existing skyline and urban dynamics. Following this, community engagement emerges again as another cornerstone of successful infill architecture, demonstrating the necessity of incorporating resident feedback throughout the planning process. Notably, while visual quality and compatibility within the urban environment received significant attention, zoning and regulatory considerations were deemed less critical. This finding suggests a potential shift in priorities among developers, where aesthetic and contextual factors may outweigh regulatory frameworks in guiding design decisions. Ultimately, the guidelines advocate for a transformative approach in urban planning that respects and enhances communities' cultural and aesthetic landscape.

IV. CONCLUSION AND RECOMMENDATIONS

To develop a comprehensive approach for evaluating infill architecture case studies focusing on urban areas experiencing growth problems, this research investigated the principles of infill development and the components of its architecture. The researchers arrived at the following conclusions through the comprehensive analysis of related literature.

First, the characteristics of infill sites allow them to be categorized into three main types—brownfield, greyfield, and greenfield— and into sub-categories of infill plots, namely gapsite and backland. These characteristics are based on the infill site's urban context, economic and social condition, land use and function, site exposure and accessibility, environmental quality, spatial characteristics, and design considerations. This evaluation method makes potential infill sites identifiable through their different characteristics. Second, while infill solutions are specific to their problem and context, there is a notable association of infill development with sustainability and green building techniques, as seen in the number of case studies that approached infill projects using this strategy. Depending on the type of infill architecture, whether mixed-use, adaptive reuse, or transit-oriented, sustainable consideration is a prevailing commonality. The same is true for strategies for infill development. While strategies largely depend on the project's needs, green building techniques tend to apply to almost any situation, on top of being a desirable attribute. Third are the design considerations for infill architecture in the form of key success factors (KSF) and guidelines. It is of utmost importance for the success of the infill project that it integrates well into its context. Such can be achieved by considering community engagement or participation in the planning process to ensure integration of the infill project into the community through social acceptance and by designing towards compatibility, integrating the infill project by visually making it coherent with the existing neighborhood character. It is important to investigate existing guidelines, not necessarily just infill guidelines— that promote the same objective as these KSFs.

This research addresses a pressing global concern of uncontrolled urban expansion faced by highly urbanized cities in the Philippines. The detrimental effects of the rapid urban land expansion driven by population growth— environmental degradation and lack of proper services and infrastructure, demand urgent attention, particularly in the context of Sustainable Development Goal (SDG) 11. This goal emphasizes the need for effective urban planning and management to address the challenges posed by urban sprawl and ensure that cities and human settlements are inclusive, safe, resilient, and sustainable. Concerning such issues, this study explores infill development as a possible solution to containing urban sprawl by developing vacant or underutilized land within existing urban areas, examining existing guidelines, and determining the methodology and characteristics of infill development and architecture. As residents of a city facing urban growth problems, the researchers have an indirect

responsibility to try to better their community within the capacity of their skills. This research aims to contribute to filling the significant knowledge gap regarding the inadequacies of existing theoretical models and methodologies for infill development and architecture. Urban infill development is promoted by identifying a method for infill architecture that aligns with the local government's objective of developing plans and strategies for smart growth. The research not only sets a precedent for initiatives aimed at achieving sustainable development goals but also promotes sustainable urban development by trying to address the environmental and socio-economic challenges posed by urban sprawl to the subsequent benefit of the locals, as well as reinforcing the global commitment to sustainable urbanization.

In conclusion, while the concept of infill development has existed for some time now, this study further supports the necessity of thorough and strategic planning and innovative design for optimizing underutilized land when approaching infill development.

The research used purely literature-based methods. Given its qualitative nature, researchers wishing to provide further knowledge on the principles of infill development and the components of its architecture are recommended to supplement this study's findings using more quantitative means where applicable. By addressing this gap, subsequent research can contribute a more comprehensive understanding of infill architecture's role in shaping sustainable urban environments.

REFERENCES

- Abbas, A. (2024). The Effect of Infill Architecture on the Heritage Context of Heliopolis_VFC. *Journal of Al-Azhar University Engineering Sector*, 19(70), 152–172. <https://doi.org/10.21608/aej.2023.240198.1438>
- Abd-Elkawy, A. (2023). Principles of Infill Development Policy towards Sustainable Urban Containment in Residential Areas. In *SVU-International Journal of Engineering Sciences and Applications*. Retrieved from https://svusrc.journals.ekb.eg/article_292912_73701f0059c848b8522e9cb95f34a761.pdf
- Abedini, A., & Khalili, A. (2019). Determining the capacity infill development in growing metropolitans: A case study of Urmia city. *Journal of Urban Management*, 8(2), 316–327. <https://doi.org/10.1016/j.jum.2019.04.001>
- Al-Abide, Z. M., Al-Dabbagh, J. A., & Al-Ani, M. Q. (2020). Infilling and architectural addition and its effect on the integration of the contemporary city townscape. *IOP Conference Series Materials Science and Engineering*, 870(1), 012047. <https://doi.org/10.1088/1757-899x/870/1/012047>
- Alfirevic, D., & Shermann, K. (2015). Infill architecture: Design approaches for in-between buildings and 'bond' as integrative element. *Arhitektura i Urbanizam*, 2015, 24-39. DOI:10.5937/A-U0-8293
- Al-Hasany, H. (2018). Urban Infill Processes and Their Role in Achieving the Main Objectives within the Old Urban Fabric. *Journal of Engineering and Architecture* 6(2) <https://doi.org/10.15640/jns.v6n2a3>
- AlHasawi, M., Maatouk, M. M. H., & Qurunfulah, E. (2024). Key Success Factors of Urban Infill Development: A Conceptual Framework. *European Journal of Architecture and Urban Planning*, 3(3), 9–17. <https://doi.org/10.24018/ejarch.2024.3.3.40>
- Alitany, A. (2019). Identifying Architectural Attributes and Aesthetics for Assessment of New Infill Design in Urban Historic Context: The Case of Historic Jeddah. In *XIII CTV 2019 Proceedings: XIII International Conference on Virtual City and Territory: "Challenges and paradigms of the contemporary city"*: UPC, Barcelona, October 2-4, 2019. Barcelona: CPSV, 2019, p. 8502. E-ISSN 2604-6512. Retrieved from: <https://upcommons.upc.edu/bitstream/handle/2117/185532/8502-8953-1-PB.pdf?sequence=1&isAllowed=y>
- Aly, S., Attwa, Y. (2013). Infill development as an approach for promoting compactness of urban form. *WIT Transactions on Ecology and The Environment*, Vol 173. doi:10.2495/SDP130381
- Archistar. (2022, November 21). Guidelines for infill developments. https://www.archistar.ai/blog/guidelines-for-infill-developments/?fbclid=IwY2xjawFFf21leHRuA2FibQIxMAABHbsqT44BSde_Q5WbDI4N85204fY4J_9Gx2s_n7eNOnFVprkbRyCwqKpd2_A_aem_G1XUNhN6fRkLU-bH9fpXKq
- Austin, B. (2014). Infill Development in a Post-redevelopment World. *Domus Development*. https://www.bernadetteaustin.org/uploads/1/4/4/7/1447286/infill_development_in_a_post-redevelopment_world.pdf
- Beiglu, F., Ghafari, S., Taheri, A. (2019). Infill Architecture as a Solution for Livability and Historical Texture Quality Promotion. *Civil Engineering Journal* 5(1). DOI: 10.28991/cej-2019-03091234
- Chabot, B. (2021). Learning from Sudburbanism: An Identity-Based Infill Framework for Downtown Sudbury. Retrieved from: <https://laurentian.scholaris.ca/items/0b4b1ece-0cfe-42d7-8a3b-8b75ce2929d0>
- Brunes, F., Hermansson, C., Song, H.-S. and Wilhelmsson, M. (2020). NIMBYs for the rich and YIMBYs for the poor: analyzing the property price effects of infill development, *Journal of European Real Estate Research*, Vol. 13 No. 1, pp. 55-81. <https://doi.org/10.1108/JERER-11-2019-0042>.
- Byahut, S., Mittal, J. (2020). Can Haphazard Growth in Urban Villages Be Prevented? Experience from the Ahmedabad-Gandhinagar Region. In: Patnaik, S., Sen, S., Mahmoud, M. (eds) *Smart Village Technology. Modeling and Optimization in Science and Technologies*, vol 17. Springer, Cham. https://doi.org/10.1007/978-3-030-37794-6_7.
- City of Georgetown. (n.d.). Design Guidelines for Infill Construction in Area 2. In *City of Georgetown* (p. 129). <https://cms3.revize.com/revize/georgetownx/Documents/Development%20Services/Planning/Historic%20Preservation/Design%20Guideline/s/Chapter-13-Guidelines-for-Infill-Construction-in-Area-2-1.pdf>
- City of Portland Bureau of Planning. (2008). *The Infill Design Toolkit: Medium density Residential Development - A Guide to Integrating Infill Development into Portland's Neighborhoods*. https://www.portland.gov/sites/default/files/2020-01/toolkit1208-optimized_bkmrks.pdf
- Clayton F., Amborski, D. (2022). Is All Greenfield Development in the Greater Toronto and Hamilton Area Sprawl? A Resounding No. https://www.torontomu.ca/content/dam/centre-urban-research-land-development/BLOG/blogentry68/CUR_Greenfield_Development_GT_HA_July_2022.pdf
- Dong, W., & Lin, G. (2024). Integrated Decision-Making of Urban Agriculture within the Greyfield Regeneration Environments (UAGR). *Buildings*, 14(5), 1415. <https://www.mdpi.com/2075-5309/14/5/1415>
- Dühr, S., Berry, S., & Moore, T. (2023). Sustainable housing at a neighbourhood scale, AHURI Final Report No. 396, Australian Housing and Urban Research Institute Limited, Melbourne, <https://www.ahuri.edu.au/research/final-reports/396>, doi: 10.18408/ahuri3228101.
- Ehrhardt, D., Behnisch, M., Michaeli, M., Jehling, M. (2025). Understanding incremental densification – Determinants of residential infill on vacant lots, *Landscape and Urban Planning*, Volume 260, 2025, 105375, ISSN 0169-2046, <https://doi.org/10.1016/j.landurbplan.2025.105375>.
- ElShater, A., Abusaada, H., Tarek, M., Afifi, S. (2022). Designing the socio-spatial context: Urban infill, liveability, and conviviality. *Built Environment* 48(3):341-363. DOI:10.2148/benv.48.3.341
- Feisal, Z. (2019). Infill design in heritage sites study of experts' preferences and attitudes. *Journal of Engineering & Applied Science* 66(4). Retrieved from: https://www.researchgate.net/publication/332974494_INFILL_DESIGN_IN_HERITAGE_SITES_STUDY_OF_EXPERTS%27_PREFERENCES_AND_ATTITUDES
- Ferrick, A. (2022). The infill neighbourhood. Te Herenga Waka—Victoria University of Wellington. <https://doi.org/10.26686/wgtn.21218414>

- GAWA. (2024). Good Design Guide: Clever ideas for infill housing. Government Architect Western Australia. Retrieved from <https://www.wa.gov.au/system/files/2024-05/gawa-good-design-guide-infill.pdf>
- GLA (2011). Delivering infill development. Greater London Authority. https://www.london.gov.uk/sites/default/files/gla_migrate_files_destination/Delivering-Infill-Development.pdf
- Glumac, B. & Decoville, A. (2020). Brownfield Redevelopment Challenges: A Luxembourg Example. *Journal of Urban Planning and Development*, 146. 05020001-1. 10.1061/(ASCE)UP.1943-5444.0000565.
- He, D., Zainol, R., Azali, N. (2024). A systematic literature review of brownfield sustainability: Dimensions, indicators, and stakeholders. <https://doi.org/10.1016/j.heliyon.2024.e38998>
- Heberle, L., Kackar, A. (2006). Connecting Smart Growth and Brownfields Redevelopment. Center for Environmental Policy and Management. <https://louisville.edu/cepm/pdf-files/connecting-smart-growth-and-brownfields>
- Herczeg, B. (2014). Reweaving the Urban Fabric: Examining Greyfield Redevelopment in the Greater Toronto Area. <https://api.semanticscholar.org/CorpusID:132582426>
- Jansson, M., Schneider, J. (2023). The Welfare Landscape and Densification—Residents' Relations to Local Outdoor Environments Affected by Infill Development. <https://doi.org/10.3390/land12112021>
- Jong, M. (2019). Environmental Sustainability in Urban Infill projects. Retrieved from: <https://studenttheses.uu.nl/bitstream/handle/20.500.12932/34326/Master%20Thesis%20Mitchell%20De%20Jong%202019.pdf?sequence=2>
- Khadour, N., Fekete, A., Sárosataki, M. (2023). The Role of the Master Plan in City Development, Latakia Master Plan in an International Context. *Land*, 2023; 12(8):1634. <https://doi.org/10.3390/land12081634>
- Korsunsky, A. (2019). From vacant land to urban fallows: a permacultural approach to wasted land in cities and suburbs. *Journal of Political Ecology* 26(1), 282-304. <https://doi.org/10.2458/v26i1.22949>
- Kosunen, H., Atkova, I. (2019). Alternative Approaches to Urban Regeneration and Infill Planning. Retrieved from: <https://doi.org/10.37457/arf.121666>
- Laine, M., Leino, H., & Santaoja, M. (2018). Building Citizens' Trust in Urban Infill: A Dynamic Approach. *Journal of Planning Education and Research*. <https://doi.org/10.1177/0739456X18817089>
- Lewyn, M. (2015). Yes to Infill, No to Nuisance. 42 Fordham Urb. L.J. 841 (2015), Touro Law Center Legal Studies Research Paper Series No. 16-04, U. of Pittsburgh Legal Studies Research Paper No. 2015-42, SSRN: <https://ssrn.com/abstract=2681195>
- Litman, T. (2015). Smart Growth Reforms Changing Planning, Regulatory and Fiscal Practices to Support More Efficient Land Use. https://vtpi.org/smart_growth_reforms.pdf
- Madigan, D. (2023). Bluefield Housing as Alternative Infill for the Suburbs. <https://doi.org/10.4324/9781003293736>
- Mahmmedi, C., Mahdjoubi, L., Booth, C.A., & Butt, T.E. (2022). Framework for preliminary risk assessment of brownfield sites. Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/S0048969721061477>
- MDP. (2001). Managing Maryland's Growth: Models and Guidelines for Infill Development. Maryland Department of Planning. https://planning.maryland.gov/Documents/OurProducts/publications/modelsguidelines/infillfinal_1.pdf
- Mehdipour, A., Kellest, J., Palazzo, E., & Larbi, M. (2024). Policy integration for brownfield regeneration: an analytical tool. *Sustainable Horizons*, 10, 100085. DOI:10.1016/j.horiz.2023.100085
- Mohammed, I., Alshuwaikhat, H., & Adenle, Y. (2016). An approach to assess the effectiveness of smart growth in achieving sustainable development. *Sustainability*, 8(4), 397. <https://doi.org/10.3390/su8040397>
- Momeni, F., Keyhanfar, M. (2017). Sustainable Urban Regeneration with a Physical Infill Development Approach: a Case Study on Isfahan Central Region. *Journal of History Culture and Art Research* 5(4):355. DOI:10.7596/taksad.v5i4.611 New Hampshire Planning and Zoning Conference. (2024). Infill Development and Design Guidelines. <https://www.nheconomy.com/getmedia/4b132253-d61e-4b3f-a0fd-0b6400209867/Infill-Development-and-Design-Guidelines-Slides.pdf>
- Newton, P. W., Newman, P. W., Glackin, S., & Thomson, G. (2022). Greening the greyfields: new models for regenerating the middle suburbs of low-density cities (p. 192). Springer Nature.
- Newton, P., & Glackin, S. (2014). Understanding Infill: towards new policy and practice for urban regeneration in the established suburbs of Australia's cities. *Urban Policy and Research*, 32(2), 121–143. <https://doi.org/10.1080/08111146.2013.877389>
- Oliver, L., Ferber, U., Grimski, D., Millar, K., & Nathanail, P. (2005, April). The scale and nature of European brownfields. In CABERNET 2005-international conference on managing urban land LQM Ltd, Nottingham, UK, Belfast, Northern Ireland, UK (pp. 5-6).
- Ostanevics, M. (2017). Infill Development in context: Case study of Riga Circus Extension. DIVA. <https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1137414&dswid=1102>
- PCPPWD (2021). Urban Infill Design and Lot Creation Standards. Pierce County Planning and Public Works Department. https://www.piercecountywa.gov/DocumentCenter/View/108430/Urban-Infill-Lunch-Learn-Training_FINALDRAFT
- Quezon City Council. (2016). Urban Design Guidelines and Standards of Quezon City. <https://quezoncitycouncil.ph/ordinance/SP/SP-2508,%20S-2016.pdf>
- Rahmat, F., Yuli, N. G., & Maharika, I. F. (2022). Infill Architecture: Contextualizing Design in an Urban Setting. *Engineering and Technology Quarterly Reviews*, Vol.5(No.2), 1–17. <https://www.asianinstituteofresearch.org/>
- Reynolds, L. (2015). Quicker, easier, cheaper?: the efficacy of CEQA streamlining for infill development. <http://hdl.handle.net/10211.3/139423>
- Santos, T., Ramalheite, F. (2024) Urban Transformation: Analyzing the Combined Forces of Vacant Building Occupancy and Socio-Economic Dynamics. *Sustainability*, 2024; 16(11):4351. <https://doi.org/10.3390/su16114351>
- Schiller, G., Blum, A., Hecht, R., Oertel, H., Ferber, U., & Meinel, G. (2021). Urban infill development potential in Germany: comparing survey and GIS data. *Buildings and Cities*, 2(1), 36–54. Retrieved from: <https://doi.org/10.5334/bc.69>
- Shamarti, A. & Shammari, H. (2020). Urban Infill as a Tool to Activate the Quality of Life in Traditional Cities. *IOP Conference Series: Materials Science and Engineering*. DOI: 870.012010.10.1088/1757-899X/870/1/012010
- Soemardiono, B., & Ardianta, D. A. (2016). The role of infill building in the sustainable conservation: Case study – Surabaya downtown. *IPTEK Journal of Proceedings Series*, (3), 1–6. <https://doi.org/10.12962/j23546026.v2017i3.2610>
- Sree, G. N. N., Sree, D. S. K., D., & Thrinethral. (2020). Smart Urban Growth: Understanding urban infill and its impact [Journal-article]. *International Journal of Engineering Research and Applications*, 6, 6–22. <https://doi.org/10.9790/9622-1006080622>
- Swansea Council (2014). Infill and backland development. https://swansea.gov.uk/media/2875/LB343---MAP/pdf/LB343_-_MAP.pdf
- Tabrizi, H.J. (2019). DESIGN POLICY AND PROCESS THROUGH INFILL DEVELOPMENT. Retrieved from: <https://open.metu.edu.tr/handle/11511/43534>
- TGMP. (1999). The Infill and Redevelopment Code Handbook. https://www.oregon.gov/lcd/Publications/Infill_Redevelopment_Code_Handbook_1999.pdf
- Tureckova, K. (2021). Specific Types and Categorizations of Brownfields: Synthesis of Individual Approaches. *Geographia Technica* 16(2):29-39. DOI:10.21163/GT_2021.162.03
- U.S. EPA. (2011). Smart Growth: A Guide to Developing and Implementing Greenhouse Gas Reductions Programs. U.S. Environmental Protection Agency. https://19january2017snapshot.epa.gov/sites/production/files/2015-08/documents/sm_growth_guide.pdf
- USING QUANTITATIVE ANALYSIS TO ASSESS THE APPROPRIATENESS OF INFILL BUILDINGS IN HISTORIC SETTINGS on JSTOR. (n.d.). [www.jstor.org. https://www.jstor.org/stable/44987221](https://www.jstor.org/stable/44987221)
- Vos, R. (2024). Voices from the City: Strategies for Inclusive Participation in Urban Redevelopment. Rijksuniversiteit Groninge. https://frw.studenttheses.ub.rug.nl/4622/1/VosRensFinalThesiss379726_0.pdf
- Wan, Y., Chen, S., Liu, J., & Jin, L. (2024). Brownfield-related studies in the context of climate change: A comprehensive review and future

- prospects. Heliyon, 10(4).
<https://doi.org/10.1016/j.heliyon.2024.e25784>
- Wang, R. (2019). Urban design Challenges with High-Rise Infill in Mature Neighborhoods. CTBUH Research Paper. <https://global.ctbuh.org/resources/papers/download/4288-urban-design-challenges-with-high-rise-infill-in-mature-neighborhoods.pdf>
- Winig, B., Wooten, H., & Allbee, A. (2014). Building in Healthy Infill. ChangeLab Solutions. https://www.changelabsolutions.org/sites/default/files/Building_In_Healthy_Infill-FINAL-20140731.pdf
- World Bank. (2015). East Asia's Changing Urban Landscape: Measure a Decade of Spatial Growth. Urban Development Series, Washington, DC: World Bank. doi: 10.1596/978-1-4648-0363-5.
- Yasin, M., Yusoff, M., Abdullah, J., & Noor, N. (2020). Is urban sprawl a threat to sustainable development? A review of characteristics and consequences. Malaysian Journal of Society and Space 16(4). <https://ejournal.ukm.my/gmjss/article/view/409>
- Zapata-Diomedí, B., Boulangé, C., Giles-Corti, B. et al. (2019). Physical activity-related health and economic benefits of building walkable neighbourhoods: a modelled comparison between brownfield and greenfield developments. Int J Behav Nutr Phys Act 16, 11 (2019). <https://doi.org/10.1186/s12966-019-0775-8>
-

The author/s retain the copyright to this article, with IJAESSI granted first publication rights. This article is distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0>), allowing for open access.