



Adaptation and Flexibility of Residential Spatial Planning to the Functions of Home-Based Industries in Small Industrial Settlements

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Abstract

Small-Scale Industrial Settlements or Perkampungan Industri Kecil (PIK) are areas that have developed through the integration of residential and home-based industrial functions, giving rise to a need for adaptive and flexible spaces. The lack of responsive spatial planning in this context often leads to problems such as overcrowding, a decline in environmental quality, and conflicts of function between living and working areas. This study identifies patterns of spatial adaptation in accommodating home-based industrial activities, analyses factors influencing spatial flexibility, evaluates the impact of spatial transformation on residents' well-being, and formulates flexibility-based design strategies. The research methodology employs a mixed-methods approach (qualitative and quantitative), utilizing field observation, interviews, and spatial analysis. The findings indicate that the separation of spatial functions (vertical, horizontal, or integrated) is influenced by the type of business, land area, and socio-economic conditions. Flexible housing designs have been shown to enhance production efficiency and living comfort. This study contributes by providing a flexible housing design model and recommendations for adaptive spatial planning policies for the PIK area.

Keywords: flexible housing design, home-based industry, small industrial settlements, spatial adaptation, spatial flexibility

Adaptasi dan Fleksibilitas Tata Ruang Hunian terhadap Fungsi Industri Rumahan di Perkampungan Industri Kecil

Abstrak

Perkampungan Industri Kecil (PIK) merupakan kawasan yang berkembang melalui penggabungan antara fungsi hunian dan industri rumahan, yang memunculkan kebutuhan akan ruang adaptif dan fleksibel. Ketidakterpenuhinya perencanaan tata ruang yang responsif dalam konteks ini sering menimbulkan masalah seperti kepadatan ruang, penurunan kualitas lingkungan, serta konflik fungsi antara area tinggal dan area kerja. Penelitian ini mengidentifikasi pola adaptasi ruang dalam mengakomodasi aktivitas industri rumahan, menganalisis faktor yang memengaruhi fleksibilitas tata ruang, mengevaluasi dampak transformasi ruang terhadap kesejahteraan penghuni, dan merumuskan strategi desain berbasis fleksibilitas. Metode penelitian menggunakan pendekatan campuran (kualitatif dan kuantitatif), dengan teknik observasi lapangan, wawancara, dan analisis tata ruang. Temuan menunjukkan bahwa pemisahan fungsi ruang (vertikal, horizontal, menyatu) dipengaruhi oleh jenis usaha, luas lahan, dan kondisi sosial-ekonomi. Rancangan hunian yang fleksibel terbukti meningkatkan efisiensi produksi serta kenyamanan tinggal. Studi ini memberikan kontribusi dalam bentuk model desain hunian fleksibel dan rekomendasi kebijakan tata ruang adaptif bagi kawasan PIK.

Kata-kunci: desain rumah fleksibel, adaptasi spasial, fleksibilitas spasial, industri rumahan, Perkampungan Industri Kecil (PIK)

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Introduction

Small-Scale Industrial Settlements or *Perkampungan Industri Kecil (PIK)* are a form of urban settlement that has developed organically in response to the economic needs of the lower-middle class. In the context of major cities in Indonesia, these areas are generally characterized by the use of residential spaces that double as production sites for home-based industries such as garment manufacturing, handicrafts and processed foods. This phenomenon gives rise to a unique dual spatial configuration, namely the home as both a domestic space and an economic space (Fig. 2). However, in practice, the integration of residential and production functions often gives rise to various architectural and social issues.



Figure 1. The atmosphere of the PIK area

The lack of adaptive and flexible spatial planning has led to many homes in PIK suffering from overcrowding, poor air circulation and natural lighting, as well as a tension between the need for private and public space. Adjustments to the function of spaces have been made gradually and are often improvised, without professional design guidance.

Small-scale industrial settlements (PIK) have undergone functional development as a result of the integration of domestic activities and cottage industry production [1]. This housing model addresses the economic needs of urban communities, particularly the informal sector, by transforming homes into both living spaces and workplaces [2].

However, this phenomenon gives rise to spatial issues such as overcrowding, overlapping functions, reduced comfort, and poor quality of the residential environment. This situation affects not only the comfort of living, but also the productivity and health of residents. Moreover, the post-pandemic economic landscape and competition from large industries have left many home-based businesses in a socially and economically vulnerable position (Fig. 2).

The development of Small-Scale Industrial Settlements (PIK) as a form of integration between residential and production spaces exhibits complex spatial dynamics and often grows organically without adequate architectural planning [3], [4]. Several studies have examined spatial adaptation strategies, such as the integration of residential and commercial functions through vertical housing in densely populated areas [3].



Figure 2. A home setting with garment manufacturing activities

The phenomenon of spatial adaptation on a micro-scale is also observed in the context of urban villages, where semi-public spaces are utilized for home-based industrial production, albeit often at the expense of comfort [5]. Other studies highlight the importance of flexible residential design in supporting the sustainability of home-based businesses [6], as well as the link between spatial planning and the productivity and well-being of residents [7].

In theory, the spontaneous transformation of residential spaces driven by the needs of home-based industries should be approached through the principles of vernacular architecture, which support spatial flexibility and multifunctionality [8]. This adaptive approach is further reinforced by recent research highlighting the importance of spatial flexibility in coping with economic and social pressures in densely populated areas [9]. The phenomenon of adapting domestic spaces for industrial production functions, as seen in the

previous study [10], demonstrates how the footwear industry influences the spatial typology of homes in Kelurahan Cikaret, Bogor.

In the literature review, the concepts of spatial adaptation and design flexibility have been extensively discussed through the lenses of participatory architecture, modular design, and open building theory [11]. Flexibility is regarded as key to the sustainability of residential spaces, where spaces can evolve to meet users' needs over time [12]. Another study [6] demonstrates that flexible house design is significantly capable of enhancing the productivity of home-based industry practitioners without compromising domestic comfort. However, most of the available literature remains limited to single-dwelling case studies or does not specifically target the PIK area as a spatial and social unit of study.

A literature review of national and international journal articles published between 2013 and 2025 reveals that the majority of previous research has focused on single-dwelling studies using formal approaches, such as conventional housing typologies [13], terraced house studies [14], and the application of modular design in formal urban settings [15]. These studies have not yet highlighted the dynamics of multifunctional residential spaces in organically growing informal environments, such as PIK Jakarta. Consequently, this research occupies an important position in bridging the gap between the theory of spatial flexibility and the spatial reality of home-based industrial settlements. Therefore, research is needed to bridge the gap between the theory of adaptive architecture and the spatial reality of dense urban home-based industrial environments.

The focus of this study lies in how residents in PIK adapt their living spaces to support home-based industrial activities, and to what extent the flexibility of these spaces impacts residents' well-being and economic sustainability.

Therefore, this study aims to (1) identify patterns of spatial adaptation by PIK residents to support home-based industrial functions, (2) analyze the factors influencing spatial flexibility, (3) evaluate the impact of spatial transformation on residents' well-being, and (4) formulate spatial design strategies based on flexibility.

Methods

The method used in this study is a mixed-methods approach [16], which combines qualitative and quantitative methods to provide a comprehensive picture and ensure robust data triangulation. This

approach was chosen because the phenomenon under study is complex, multidimensional, and involves both spatial-physical and social (occupants and activities) aspects.

A qualitative approach was used to understand spatial adaptation behaviors through field observations and in-depth interviews, while a quantitative approach was used to supplement the data with basic measurements such as the area of production spaces, the number of occupants, and the intensity of business activities. The two approaches were integrated through a process of triangulation, in which the results of observations and interviews were compared with numerical field data to enhance the validity and reliability of the findings (Fig. 3).

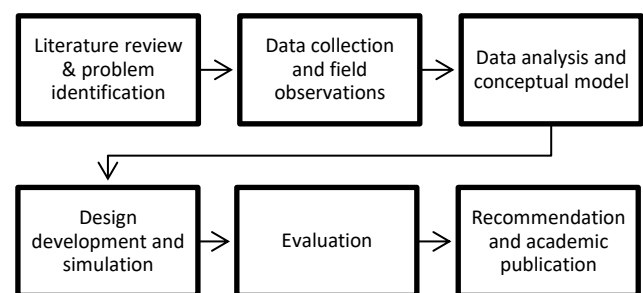


Figure 3. Research flowchart

This study is descriptive-exploratory in design. It is descriptive because it details and maps the phenomena observed in the field, and exploratory because it aims to identify patterns of spatial adaptation and flexibility strategies that have not been systematically documented in the existing literature [17], [18].

The primary approach used is the case study method. The selection of the case study location in the PIK area of Jakarta was conducted purposively because this area represents the oldest and most active residential-industrial model in Jakarta. Three households were selected as samples to provide a variety of business typologies (food, handicrafts, and garment manufacturing) as well as depth of analysis in each case.

Although the sample size is limited, the depth of observation and interviews in each case provides a representative contextual picture, even though it is not intended for generalization. The case study approach allows for in-depth observation of spatial adaptation practices within a specific context, thereby enabling the derivation of meaningful contextual findings.

Data Collection Methods

This study employed three primary methods of data collection: field observation, semi-structured interviews, and documentary analysis.

Observations were conducted directly in three homes within the Small Industrial Village (PIK) area, which serve as both residences and business premises, focusing on spatial configuration, adaptation patterns, and functional separation.

Interviews were conducted with the homeowners to explore the reasons for spatial adaptation, the challenges faced, and their perceptions of comfort and productivity. The documentary study involved collecting floor plan photographs, visual documentation, as well as relevant literature and archives as supporting data.

Samples were selected purposively from three homes with different types of businesses (food, handicrafts, and garment manufacturing) that demonstrated variations in spatial adaptation. Data collection took place from February to July 2025.

Data Analysis Methods

The data analysis method in this study employs a qualitative thematic analysis approach, supported by basic numerical data to bolster the analysis. The quantitative analysis in this study is not inferential in nature; rather, it is used descriptively to present measurements of space, the number of occupants, and the intensity of business activities as supporting data for the qualitative analysis, thereby helping to clarify patterns of spatial adaptation. Thus, the contribution of the quantitative approach within a mixed-methods framework lies in its ability to complement observational findings and interviews through the comparison of measurable empirical data.

The analysis process is conducted in three main stages: data reduction, data presentation, and drawing conclusions. Data reduction involves grouping information into categories: spatial adaptation patterns, forms of functional separation (vertical, horizontal, integrated), and levels of spatial flexibility. Data presentation is carried out through comparative tables between cases (respondents A, B, and C), spatial floor plans, and schematic diagrams of spatial functions.

Conclusions were drawn by interpreting the findings through the theoretical framework of adaptive and flexible architecture, and comparing them with findings in the existing literature (state of the art). The analysis also considered socio-economic factors

Table 1. The illustration of the analysis results' table

Aspects of Analysis	Respondent A	Respondent B	Respondent C
Types of space division	No division / merged	Horizontal	Vertical
Structured production function	No	Partly structured	Yes
Spatial adaptation	Gradually	Partially permanent	Totally permanent

influencing spatial configuration and productivity.

Spatial analysis diagrams and supporting photographs were also prepared to reinforce the visual interpretation of spatial adaptation for each respondent (Table 1).

Results and Discussions

This study identifies three main patterns of residential spatial adaptation adopted by home-based industry operators in the Small Industrial Village (PIK) area, based on an analysis of three different respondents representing variations in business type, land area, resident age, and building structure.

Respondent A, an elderly woman (>60 years old) who runs a snack business, demonstrates a model of gradual adaptation characterized by a high degree of multifunctional space (Fig. 4). With a land area of 250 m² and a two-story building, all primary activities remain concentrated on the ground floor to facilitate



Figure 4. The front facade (left) and the interior of the business area (right) of Respondent A

mobility.

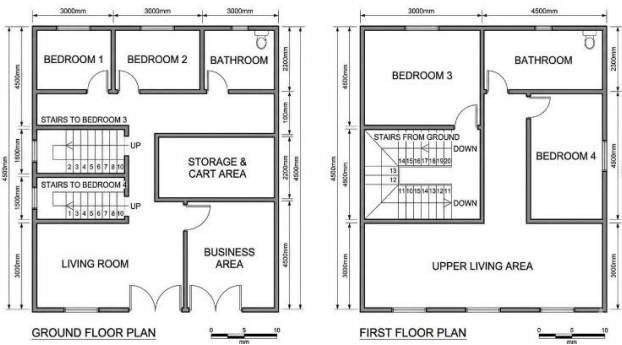


Figure 5. Floor plans of the ground floor (left) and upper floor (right) of Respondent A's existing house

The floor plans illustrate the integration of domestic and production functions within the same space, with minimal separation between zones (Fig. 5). The business space is located near the entrance but shares circulation with the family room, while the additional bedroom emerged as a spontaneous response to the family's dynamics. These adaptations reflect basic economic needs and functional responses to change, yet they compromise comfort and privacy. Respondent A explained, "I used to turn my living room into a sales area because customers often came early in the morning." This quote illustrates a form of spontaneous adaptation to daily economic needs.

Respondent B (aged 41–60), who runs a handicraft business on a 300 m² plot, has implemented a horizontal separation between the business and residential zones. The ground floor is used almost entirely for production and display, while the upper



Figure 6. The front facade (left) and the interior of the business area (right) of Respondent B

floor is used for domestic living (Fig. 6).

This adaptation reflects a systematically developed approach, featuring specialized spaces such as administrative areas, production restrooms, and exhibition zones. The domestic spaces remain intact

and undisturbed by work activities, reflecting an understanding of the importance of zoning for

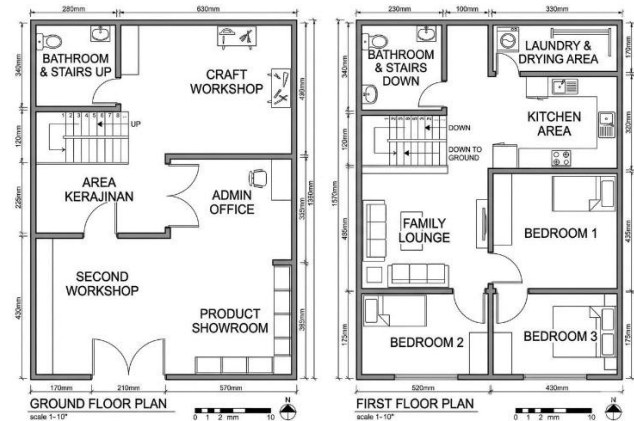


Figure 7. Floor plans of the ground floor (left) and upper floor (right) of Respondent B's existing house

productivity and work-life balance (Fig. 7).

Respondent C (aged 21–40), who runs a micro-scale garment manufacturing business and retail shop, utilizes a 600 m² space and employs a clear vertical division of functions (Fig. 8). The entire ground floor serves as a business space, complete with sewing,



Figure 8. The front facade (left) and the interior of the business area (right) of Respondent C



Figure 9. Floor plans of the ground floor (left) and upper floor (right) of Respondent C's existing house

embroidery, and ironing areas, a general store, and a break room for the employees.

Meanwhile, the upper floor serves as a living space with six bedrooms, a family room, and domestic service areas (Fig. 9). No multifunctional spaces were

found; all functions are fixed and specific. This model represents the most mature form of adaptation, supported by economic resources, a well-structured work organization, and sufficient land area. Respondent C stated, "I intentionally separated the upper floor for the family, so that workers wouldn't be coming and going through the private area." These findings reinforce the analysis that spatial flexibility is influenced not only by physical factors but also by residents' social awareness regarding privacy and productivity. This interpretation aligns with the concept of adaptive architecture, which emphasizes a balance between efficiency and user comfort.

Table 2. Comparative analysis of respondent A, B, and C

Aspects of Analysis	Respondent A	Respondent B	Respondent C
Types of business	Snacks	Handicrafts	Garment and store
Land area (sq m)	250	300	600
Number of floors	2	2	2
Separation of living and commercial spaces	No clear division / merged	Horizontal	Vertical
Adaptation scheme	Flexible and gradual	Semi-permanent	Permanent
Multifunctionality	Yes	No	No
Structured production space	No	Partly	Yes
External employee	No	No	Yes
Adaptation type	Gradual, functional	Functional divisions	Total spatial transform

Table 2 below provides a comparison of the three respondents.

The comparison table shows that the larger the scale of the business and the land area, the greater the likelihood that occupants will implement a strict and permanent separation of functions. Respondent C represents the peak of the adaptation scale, characterized by low flexibility but high efficiency, while Respondent A illustrates a spontaneous and gradual typology with high flexibility but low efficiency. Respondent B falls between these two extremes.

Factors such as the residents' age, type of business, scale of production, and involvement of external labor

also significantly influence the chosen adaptation pattern. Vertical separation (C), horizontal separation (B), and undefined separation (A) serve as indicators of the business's level of maturity, spatial readiness, and the residents' adaptive capacity.

Conclusion

This study concludes that the adaptation and flexibility of residential spatial arrangements in Small Industrial Villages (PIK) are significantly influenced by the type of business, land area, housing structure, and the socioeconomic conditions of the residents. The three main patterns of spatial adaptation identified include: (1) full integration between living and business spaces (Respondent A), (2) horizontal separation between domestic and business zones (Respondent B), and (3) strict vertical separation with permanent spatial structures (Respondent C).

The main findings indicate that homes with flexible designs enable production efficiency without compromising living comfort, particularly in residences with a clear separation of functional spaces. Spatial flexibility has proven crucial in supporting the sustainability of home-based industries, especially in dense and informal environments such as PIK.

Regarding comfort and productivity, the findings indicate that the separation of functional spaces has a positive impact on work efficiency and family well-being. Based on these results, this study proposes a flexible design strategy in the form of adaptive zoning (production, transition, and domestic) that can be applied to multifunctional housing in the PIK area of Jakarta.

The novelty of this study lies in its approach, which combines adaptive spatial analysis with a socio-economic resilience perspective, as well as its focus on the specific context of PIK, which has not been extensively examined in the architectural literature. These findings also underscore the importance of integrating modular design, functional zoning, and adaptive strategies in the design of multifunctional housing in densely populated urban areas.

The strength of this study lies in its presentation of contextual and in-depth case studies, which reflect the diversity of spatial adaptation strategies in the field. However, the main limitation lies in the limited number of respondents and the still narrow geographical scope.

For future research, it is recommended to conduct a broader exploration of various PIK areas in Indonesia

using a more in-depth quantitative and participatory approach, as well as testing flexible design models through simulations or prototypes to determine the effectiveness of their implementation on a real-world scale. Further research could also strengthen the connection between spatial design and indicators of resident well-being.

AI Use Declaration

The author used Grammarly and DeepL Translator for translation and language editing to improve clarity and readability. All content was reviewed and approved by the author, who take full responsibility for the final manuscript.

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