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Land Readjustment Model for Transit-Oriented Development (TOD) Projects: Generating Optimal Financial Benefits

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Abstract

Transit-Oriented Development (TOD) projects are increasingly recognized as vital components of sustainable urban planning, aiming to create compact, walkable, and mixed-use communities centered around high-quality public transportation systems. However, implementing TOD projects poses significant challenges, especially in land acquisition and redistribution. This research addresses these issues in the context of the MRT Jakarta project and proposes a land readjustment approach as a potential solution. The study combined qualitative and quantitative methods to compare existing and ideal land use in the TOD area and benchmark successful TOD models from different countries. A comprehensive financial analysis was performed to assess the potential financial impacts of the proposed model. The analysis reveals differences between the existing land use in the Fatmawati TOD area and the ideal TOD model, suggesting the need for adjustments to achieve better land use diversity and economic vibrancy. The financial analysis demonstrates positive feasibility for the TOD project, surpassing the minimum attractive rate of return (MARR) threshold. However, the potential value of the reserved area covers only 16% of the total land readjustment (LR) costs, indicating the necessity for further measures to enhance financial feasibility. The study proposes leveraging existing apartment buildings as temporary relocation sites, optimizing resources, and increasing overall financial viability to address substantial relocation costs. Exploring different property redistribution scenarios reveals the importance of balancing landowners' benefits with the developer's financial feasibility for a successful TOD project. Overall, this research provides valuable insights and a comprehensive framework for implementing thriving and sustainable transit-oriented communities in Jakarta. Further research and collaboration among stakeholders are essential to refine the proposed model and ensure successful TOD project implementation in the future.

Keywords: Transit-Oriented Development (TOD); Land readjustment; Financial Analysis; Sustainable Urban Planning; Land Acquisition and Redistribution.

1. Introduction

Urbanization has emerged as a significant driver for rapid growth in numerous cities worldwide, particularly in developing countries [1, 2]. It has contributed to substantial economic development and the creation of opportunities [3]. However, urbanization poses several challenges that necessitate careful attention and strategic planning. These challenges include the expansion of urban sprawl, which leads to the inefficient use of land and resources, and the

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subsequent strain on infrastructure and services [4, 5]. Traffic congestion is another critical issue associated with urbanization, resulting in increased travel times, decreased productivity, and negative environmental impacts [6, 7]. Moreover, rapid urbanization often leads to environmental degradation, including pollution, deforestation, and the depletion of natural resources [8]. Furthermore, urbanization raises public safety concerns, including crime rates and the need for effective emergency response systems [9]. The concentration of population and socioeconomic disparities in urban areas can amplify these challenges, making it crucial to address them through targeted urban planning and policy interventions.

To mitigate these challenges, cities need comprehensive and sustainable urban development strategies that prioritize efficient land use, invest in robust transportation systems, promote environmental conservation and resilience, foster job creation, ensure affordable housing, and enhance public safety [10]. Integrated approaches such as transit-oriented development (TOD) have gained traction as effective solutions for promoting sustainable urban growth, reducing dependence on private vehicles, and creating compact, mixed-use communities centered around public transportation hubs [11, 12]. The Government of Indonesia recognizes the importance of addressing the mentioned challenges and has prioritized TOD as an alternative to car-dependent infrastructure development [13]. However, implementing TOD in urban development encounters a significant obstacle: the imbalance between the available land and the land required for development [14]. In the case of Jakarta, which has recently completed the construction of mass rapid transit (MRT) and light rapid transit (LRT) systems, integrating transit with various building functions and public spaces to embrace the TOD concept presents a complex challenge [15].

A major issue in implementing TOD in Jakarta is the ownership of the land designated for TOD development around transit stations. Most of this land is already owned by developers, necessitating direct land acquisition from landowners to proceed with the planned development [16]. Land acquisition poses a challenge regarding coordination, negotiation, and fair compensation for landowners; therefore, effective land acquisition strategies and cooperation between the government, developers, and landowners are essential to ensure a smooth and inclusive transition toward TOD development in Jakarta [17]. Furthermore, to address the challenge of land availability in TOD development, the government of Indonesia can employ a land readjustment (LR) approach, locally referred to as land consolidation (LC).

LR strategies have been implemented in various regions worldwide, contributing significantly to regional economic corridors. In Japan, LR has been widely employed for diverse development objectives nationwide. Among these are the development of residential areas in peri-urban regions, urban renewal initiatives in highly urbanized areas, as well as post-disaster reconstruction efforts, and integrated urban development in conjunction with urban transport facilities. Notably, these large-scale LR initiatives have been effectively executed in major metropolitan areas, contributing to the creation and redevelopment of approximately 3,700 km² of urban spaces, which accounts for around 30 percent of Japan's total urban area [18]. The same goes for the Netherlands, which also has a well-established history of LR and successfully implemented large-scale LR projects in rural areas. However, as a strategic approach for urban development, LR is being explored, and new legislation is currently being developed in this regard. To prepare for implementing this new legislation, the country initiated a national pilot program for urban land readjustment (NPULR). This program involved stimulating and analyzing fourteen pilot projects over 2.5 years to gain valuable insights into the potential of the new instrument and encourage its active usage in future urban development endeavors. [19].

The Town Planning Scheme in Ahmedabad, India, is viewed as an inclusive and fair approach to expanding the city by acquiring land from rural landowners on the urban periphery. This mechanism empowers local authorities to acquire a portion of all land parcels in a specified area to develop public infrastructure like roads, parks, and amenities. The authorities then redistribute the remaining land back to the original landowners as reconstituted parcels, which have gained value due to the implemented improvements. In return, the landowners contribute half of this increased land value to the government as a betterment charge, which helps the government offset its expenses incurred during the development process. [20]. On the other hand, the Sardar Patel Ring Road (SPRR) project utilized LR techniques to reserve a 76-kilometer-long and 200-foot-wide right-of-way (ROW) for a regional ring road [21]. This LR implementation's success can be attributed to visionary planning, a solid legal framework, efficient land records, and public acceptance [22].

Kathmandu Valley's government has utilized LR as a valuable instrument for urban land development. A total of 22 LR projects have been successfully completed in the valley over the years, while several other projects are currently underway. A comprehensive overview of the LR technique in Kathmandu Valley has been performed to improve further and strengthen the LR process. The objective is to identify and investigate the measures required to reform the existing legal and institutional framework and to streamline the procedures involved in LR projects [23]. On the other hand, LR has emerged as a potential alternative approach to traditional land expropriation for village consolidation in Beijing's periphery. The primary goal is to address the challenges associated with village consolidation effectively. To achieve this, two simplified models have been developed: one for land expropriation and the other for LR. These models enable a focused comparison of the costs and benefits for various stakeholders involved in the consolidation process. By evaluating the outcomes of both approaches, LR is expected to provide more favorable solutions to the region's village

consolidation issues. In addition, implementing a government-led LR model in peri-urban areas of Ethiopia has resulted in several potential benefits, thereby addressing issues with the current land acquisition process. These advantages include increased participation and consensus, equitable benefit distribution, cost-effectiveness, and preservation of social networks and the environment [24, 25].

The Turkish LR method aims for equitable cost and benefit sharing among landowners through a contribution coefficient system, ensuring proportional contributions to public areas like parks and roads based on parcel value [26]. However, some weaknesses of the LR method in Turkey have been identified, such as limited participation, a lack of incentives for voluntary participation, and a focus on area-based calculations [26]. Key success factors for land readjustment applications in Trabzon Province, Turkey, include proper parcel boundary arrangements, accurate public partnership and development readjustment share calculations, and appropriate parcel allocation and construction [27]. In Egyptian cities, land readjustment was instrumental in enhancing housing access for the urban poor, improving housing production, and providing rental housing units, contributing to poverty reduction in line with the General Strategic Urban Plan (GSUP) project's objectives [28]. In Iran, discussions on land readjustment emphasize the importance of participation and the preservation of landowners' rights, highlighting its legal aspects [29]. According to Chen & Yang [30], LR is a comprehensive tool for urban development, promoting land use and improving living quality in a designated area. It involves reorganizing privately-owned land by local authorities to transform boundaries and facilities, facilitating infrastructure and service delivery. However, challenges may arise when connections and legal regulations between plots, building lots, and building types are lacking, leading to over-subdivided plots, mixed building types, and inadequate public facilities, potentially impacting townscape, infrastructure capacity, and project timelines.

Previous studies above illustrate that LR strategies have been successful in various contexts, positively contributing to economic development, housing accessibility, and urban infrastructure improvements. Moreover, the evidence emphasizes the significance of careful planning, robust legal frameworks, and the preservation of landowners' rights, as well as active participation and consideration of the financial advantages for all stakeholders involved. However, there remains a scarcity of studies specifically addressing the critical area of optimizing financial benefits for all stakeholders, particularly in the context of TOD projects utilizing LR techniques.5

This paper aims to bridge this research gap by presenting an optimized LR model tailored to TOD projects, ensuring favorable financial outcomes for all stakeholders engaged in TOD project development. This study contributes valuable insights to policymakers, practitioners, and researchers involved in implementing LR schemes for urban transit infrastructure development and investment project financing by addressing this gap. The proposed model provides an innovative land acquisition and utilization approach, enabling efficient and equitable development of TOD areas. These insights can inform decision-making processes and contribute to the formulation of effective policies that promote sustainable urban development and transportation systems.

1.1. Land Readjustment: Models' Characteristics and Strategies

Yoshida [31] compared LR practices in Indonesia and Japan and found that the National Land Agency or *Badan Pertanahan Nasional* (BPN) is the central authority responsible for LR in Indonesia. In contrast, in Japan, various stakeholders, including communities, individuals, associations, and local or central government entities, can be involved in the process. In Indonesia, LR primarily focuses on residential development and land registration, often without considering infrastructure development. The BPN's main role is land registration, and there is limited collaboration with other agencies. The decision-making process for LR in Indonesia requires a high consent rate of 85%, indicating a consensus-oriented approach. Furthermore, Supriatna [32] found that LR in Indonesia is mainly implemented for social housing, overlooking the potential for developing commercial areas using the available land.

LR projects can be initiated by government agencies or landowner associations. Governing regulations or laws typically outline the minimum number of participants required for project approval as a prerequisite for commencing the consolidation process. These minimum requirements can be based on the percentage of the total number of landowners, the percentage of land area owned, or a combination of both. According to Schrock [33], the Japanese LR framework necessitates the consent of two-thirds of the landowners whose lands are required to initiate private LR projects, distinct from government-led initiatives). Meanwhile, in Germany, the local government carries out LR as part of urban planning, and landowners are legally obligated to participate in the process [34]. In certain conditions, LR processes in France only require a consent rate of half the landowners [35].

Incorporating costs and infrastructure development is integral to LR implementation in certain countries. Archer [36] highlights the importance and benefits of including these aspects in the LR process. Firstly, it allows the fulfillment of infrastructure development costs, relieving the financial burden on the government. Secondly, the resulting consolidated land parcels become more valuable and marketable due to well-established infrastructure. Thirdly, it enables the estimation of land values after the consolidation process. Fourthly, it facilitates efficient city development within a specified timeframe.

Infrastructure availability prompts building construction in the area. Nevertheless, lacking costs and infrastructure integration in LR may hinder government execution, resulting in project delays to continuity gaps [35]. Additionally, the inadequate infrastructure disrupts LR in the legal framework, impacting success. Regulations can adopt a multi-structure or uni-structure approach. As in Japan and South Korea, the multi-structure approach allows for greater flexibility and local participation. On the other hand, the uni-structure approach, found in Germany and Turkey, centralizes the LR process under government, prioritizing public interest. While the multi-structure is favored for urban LR, provisions ensuring integration with land acquisition approaches are vital for effective outcomes [35].

2. Research Methods

This study adopted a two-stage approach combining qualitative and quantitative methods to achieve the research aims. The first research objective (RQ1) was to determine the optimal land use model for LR in the TOD area, while the second objective (RQ2) was to develop a LR model that offers optimal financial benefits for the stakeholders involved in the TOD project. A qualitative method addressed RQ1, where a comparative analysis was conducted between the existing TOD land use proposed by the developer and the ideal TOD land use derived from literature and benchmark studies. The data on the existing TOD land use (see Figures 1 and 2) were obtained from planning documents provided by PT MRT Jakarta, the TOD Fatmawati developer, as well as the land use zoning outlined in the DKI Jakarta Provincial Regulation No. 1 of 2014, accessed from the Jakarta Satu website [37]. Geographic Information System (GIS) software was utilized to process the collected data, enabling mapping, analysis, and digitization of the land use data. This facilitated the land area and radius distance calculation, further contributing to determining the optimal TOD land use model. To achieve the second research objective (RQ2), a benchmark study was conducted to examine successfully implemented LR models in different countries. The identified models' characteristics and strategies were carefully analyzed to determine their applicability to the optimal TOD land use model. The selected LR strategies were then incorporated into the development of the LR model.

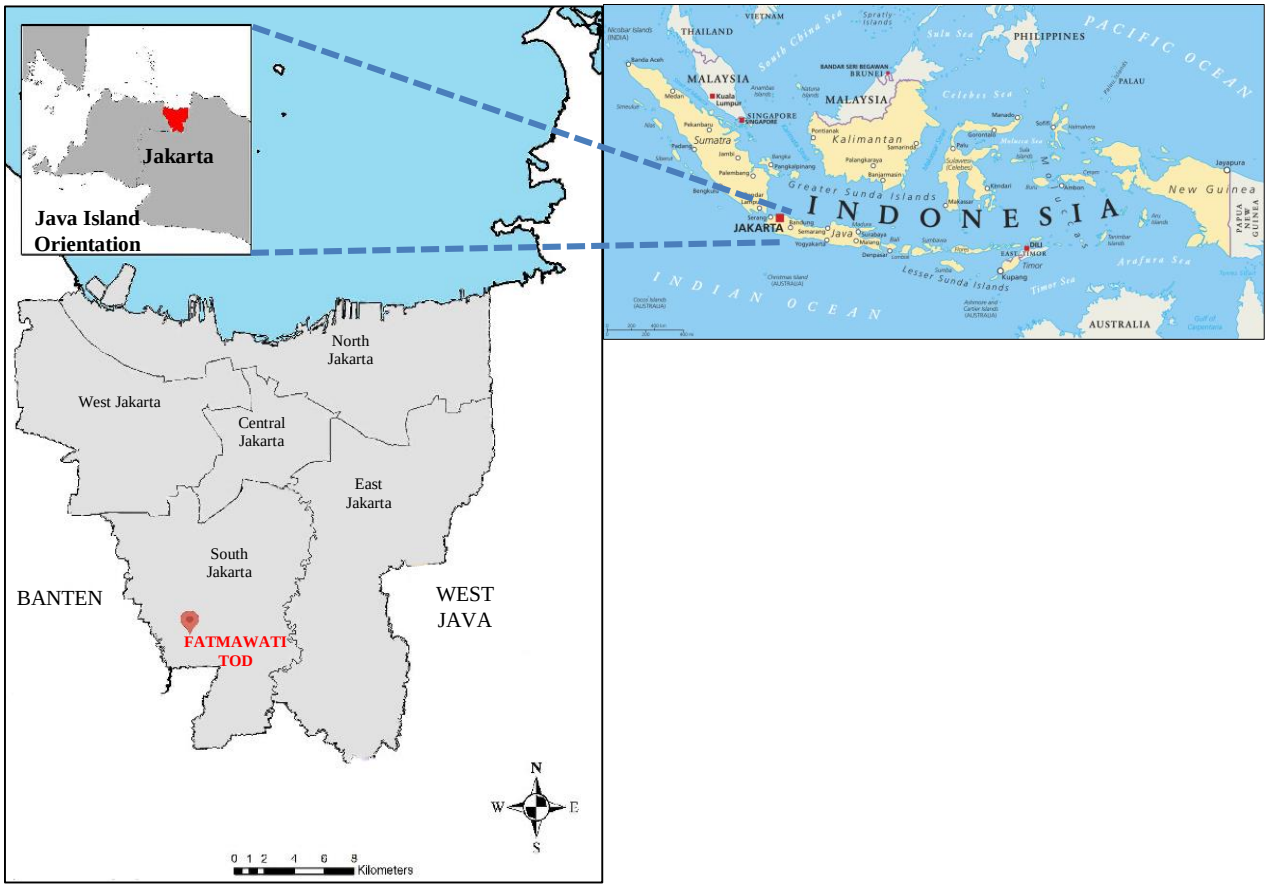

Figure 1. Location of the study area

Since LR strategies can lead to adjustments in land area, it is important to assess the potential financial impacts of the developed model. In order to do so, a comprehensive analysis was conducted to evaluate whether the implemented LR scheme could result in increased property values and deliver financial benefits for both the government and private landowners. This analysis considered land prices, project costs, and revenue in a financial simulation. The research workflow, depicting the sequence of activities performed in the study, is presented in Figure 3.

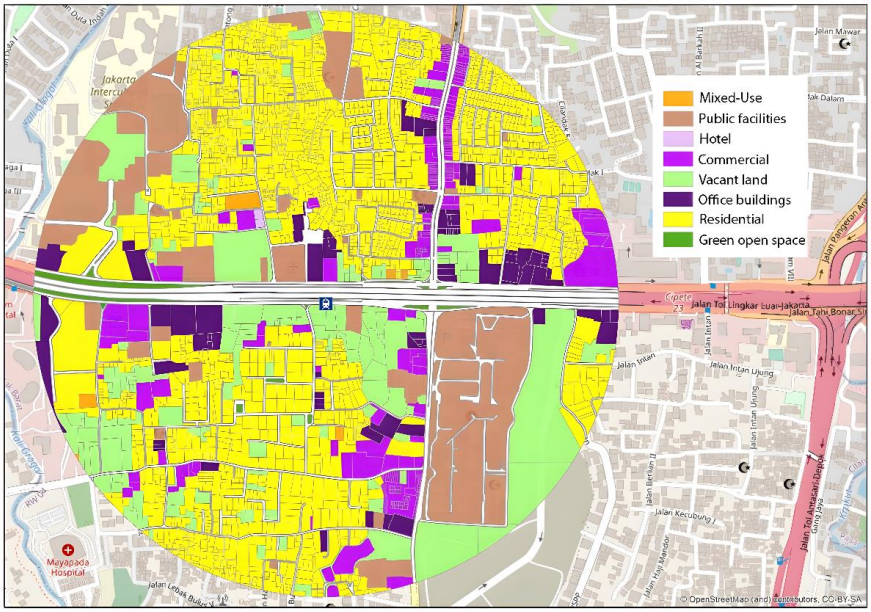

Figure 2. Map of the existing TOD Fatmawati land use

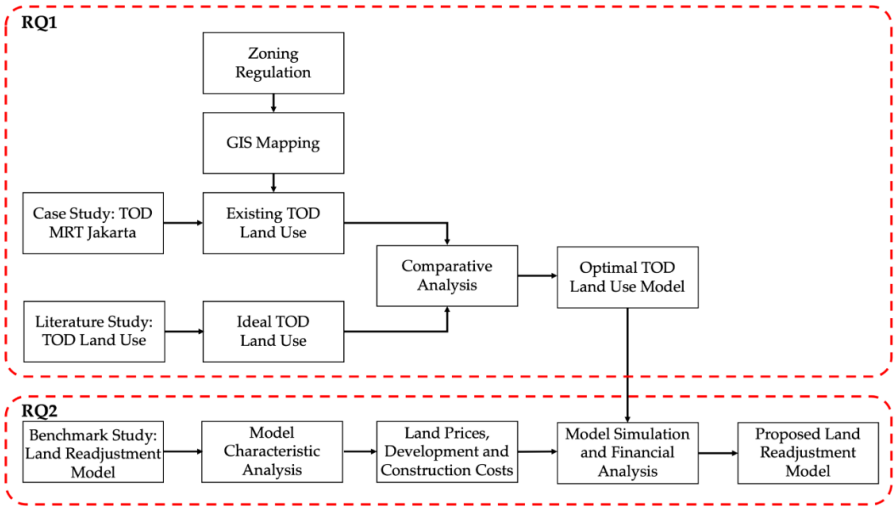

Figure 3. Research framework

In order to conduct a comparative analysis of land use in the TOD area, the existing land use and ideal land use were compared. The proportion of each land use category was calculated for both the existing and ideal conditions based on findings from literature studies (see Figure 4 and Table 1). This comparison aimed to identify the current state of land use in the TOD area and highlight any gaps between the existing and ideal conditions to optimize land use in the TOD area. Penjelasan tentang komposisi TOD.

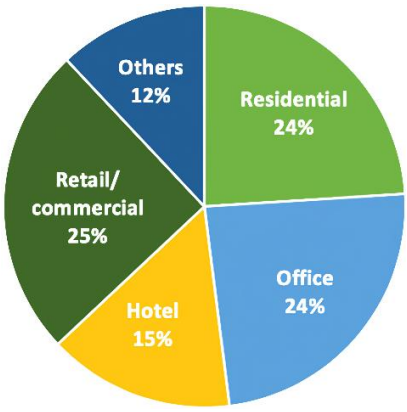

Figure 4. Optimized mixed-use allocation for the TOD [38]

Table 1. Design TOD benchmark [39]

	Hongkong (Union Square)	Japan (Namba Parks)	South Korea (D'Cube City)	Range
BCR	100%	76%	100%	76 – 100%
FAR	8.05	7.23	6.57	6.57 – 8.05
Residential	56%	24%	26%	24% – 56%
Office	21%	24%	6%	6% – 24%
Hotel	15%	0%	4%	0% – 15%
Commercial	8%	34%	25%	8% – 34%
Others	0%	18%	39%	0% – 39%

In particular, Berawi et al. [38] emphasized that TOD areas should ideally have a land use composition of 24% for residential, 24% for office, 15% for hotel, 25% for commercial, and 12% for other land uses such as green open spaces and public facilities, to achieve maximum ridership. However, findings from the benchmarking conducted by Saroji et al. [39] on three successful TOD projects worldwide revealed a wider range of land use proportions: residential ranging from 24% to 56%, office from 6% to 24%, hotel from 0% to 15%, commercial from 8% to 34%, and green open space and other uses from 0% to 39%. The benchmarking also highlighted a diverse range of building coverage ratios (BCR) from 76% to 100% and floor area ratios (FAR) ranging from 6.57 to 8.05.

ArcGIS software, which allowed for the simulation and analysis of land areas, was used to calculate the proportion of land use. Land parcels with a changed zoning function were reevaluated regarding their area and exported from ArcGIS to a spreadsheet table format. This process facilitated determining the proposed land use allocation's percentage value.

A comparative analysis of the characteristics of LR models, focusing on their application in benchmarking countries, was conducted. The scope of analysis encompassed diverse LR uses, ranging from urban and infrastructure development to agricultural applications. This comparative analysis aimed to identify land and readjustment relevant characteristics and strategies applicable to the Fatmawati TOD as the case study. Furthermore, it is expected to provide insights and guidance for implementing effective LR practices in the context of the Fatmawati TOD.

After completing the benchmarking analysis, the MRT Jakarta-developed optimal land use model for the TOD area in Jakarta was modified with the identified LR strategies. The modification involved applying a simulation process of LR to the TOD model, thereby altering the proportion of land use areas. This intervention sought to align the land use model with the identified LR strategies to the LR model in the readjustment process. The financial analysis aims to ensure that implementing LR yields favorable financial results [40]. This analysis involves various calculations related to costs and revenues. The financial analysis includes LR costs, such as compensation, relocation, and administrative expenses. In addition, the costs associated with property development and infrastructure in the TOD area are considered initial costs. Consideration is also given to operational and maintenance costs [41, 42].

The financial analysis also includes projected property revenues, consisting of sales, leases, and service charges for each property type, with Net Present Value (NPV) and Internal Rate of Return (IRR) as the primary outcomes. NPV calculates the difference between the current value of cash inflows and outflows over a specific period. On the other hand, IRR measures the rate of return on investment throughout the project's lifespan [43]. To determine the financial viability of a project, the Minimum Attractive Rate of Return (MARR) is considered. For most infrastructure projects, the MARR is typically around 12% [44]. A project is deemed financially feasible if it yields a positive NPV value and an IRR that exceeds the MARR.

3. Results and Discussion

The land use data for the Fatmawati TOD Area was obtained from the *jakartasatu.jakarta.go.id* website, owned by the DKI Jakarta Provincial Government. The data was downloaded in shapefile format and processed using GIS software, specifically ESRI ArcGIS. The area coverage was within an 800-meter radius of the Fatmawati MRT station.

The data was exported from ArcGIS to Microsoft Excel to facilitate zoning calculation and classification. After processing the data, the existing land use condition of the Fatmawati TOD Area was determined, showing the percentages of different land use types. Table 2 provides information on the zoning and intensity of land use based on DKI Regional Regulation No. 1 of 2014, which includes the values of the Building Covered Ratio (BCR) and Floor Area Ratio (FAR) for each land parcel/block.

Table 2. Zoning and intensity of land Use TOD Fatmawati

No	Zoning	Land Area		BCR	FAR
		Square meter	%		
1	Residential	1,032,448.85	57.6	48%	1.80
2	Office	186,982.05	10.4	37.7%	2.80
3	Commercial	152,247.71	8.5	44%	2.80
4	Hotel	1,219.86	0.1	60%	1.20
5	Mixed-use	11,742.53	0.7	50%	2.00
6	Public facilities	315,083.81	17.6	32.7%	1.70
7	Green open space	93,709.57	5.2	1%	0.02
	Total	1,793,434.38	100.0		

The predominant land use in the Fatmawati TOD area is residential, comprising 57.6% of the total area, while hotels occupy a minimal space of only 0.1%. Interestingly, hotels exhibit the highest BCR (Building Coefficient Ratio) value of 60%, surpassing mixed-use areas at 50% and residential areas at 48%. Regarding FAR (Floor Area Ratio), commercial and office areas have the highest value of 2.8, indicating their potential for greater floor area development.

3.1. Optimal TOD Land Use Model

According to Ewing & Cervero [45], five aspects are crucial in evaluating a TOD: density, land use diversity, pedestrian-oriented design, distance to transit, and destination accessibility. For this study, the focus was on density and diversity within the Fatmawati TOD area. Density was assessed by examining the building intensity using indicators such as FAR and BCR, regulated by regional guidelines. Diversity was evaluated based on the area's variety and allocation proportions of different zoning functions. These two aspects of the Fatmawati TOD area were compared to the TOD Benchmark (Figure 4 and Table 1) obtained from previous research.

The gaps in density and diversity can be identified by designating the TOD Benchmark as the optimal condition for TOD development. This analysis provides insights into the areas where the Fatmawati TOD area falls short in comparison to the benchmark. It emphasizes the importance of achieving optimal density and diverse land use allocations as the intended standards of a successful TOD and highlights the areas that require improvement to meet those standards.

The land use classification for the Fatmawati TOD area is initially divided into seven categories, as can be seen in Table 2. However, the classification was simplified into four categories to facilitate an equitable comparison with the TOD Benchmark (see Figure 4). The 'Hotel' and 'Mixed Use' zones are combined into the 'Commercial' category, while the 'Public Facilities' and 'Green Open Space' zones are merged into the 'Other' category. This simplification allows for a clearer and more straightforward comparison between the two TOD areas, making it easier to assess the similarities and differences in land use (see Table 3).

Table 3. TOD zoning comparison

	TOD Fatmawati	TOD Benchmark
Residential	57.6%	24%
Office	10.4%	24%
Commercial+hotel+mixed use	9.2%	40%
Others (Public facilities + Green open space)	22.8%	12%
FAR	1.2–2.8	6.57 – 8.05
BCR	32.7% – 60%	76% – 100%

The majority of land use in the Fatmawati TOD is residential, with a proportion that is 33% higher than the TOD Benchmark, as summarized in Table 3. In contrast, the percentage of commercial and office areas in the Fatmawati TOD area is lower than the TOD Benchmark by 30.8% and 13.6%, respectively. This indicates that the proportion of commercial and office areas in the Fatmawati TOD is not optimal. Furthermore, the BCR and FAR values in the TOD Benchmark range from 76% to 100% and 6 to 8, respectively. In the Fatmawati TOD area, the highest BCR and FAR are 60% and 2.8, respectively. This suggests that the BCR and FAR values in the Fatmawati TOD area are relatively lower than the ideal values observed in the TOD Benchmark areas of Hong Kong, Japan, and South Korea. Berawi et al. [46] conducted research on four LRT TODs in Jabodebek and discovered similar findings, including low BCR and FAR values and disproportionate land use diversity. The majority (69-94%) of land use in these TOD areas is designated for apartment housing. As a consequence, the total floor area available for monetization could be reduced, thereby decreasing the revenue potential for property businesses [47].

There is room for improvement in the distribution and intensity of different land uses in the Fatmawati TOD area. To align with the successful TOD models, increasing the percentage of office spaces and commercial areas is essential while considering higher BCR and FAR values. These improvements will enhance the overall vibrancy and functionality of the Fatmawati TOD area, making it more comparable to the established TOD areas in other countries.

For the Fatmawati TOD area to achieve outcomes similar to the TOD Benchmark, changes in land use allocation need to be implemented. However, there are several limitations and constraints to consider when developing a model for the allocation changes in the Fatmawati TOD area:

- The zoning allocation for "Public Facilities" and "Green Open Spaces" should be maintained and cannot be converted into other zoning categories.
- The "Residential" zone, which is the dominant land use, needs to be converted into "Commercial" and "Office" areas. However, certain residential areas, such as apartments and large housing estates, should be preserved.
- Dense residential areas or traditional settlements have the potential to be redeveloped into livable areas with adjusted zoning allocations.
- The area within a 400-meter radius of the Fatmawati MRT Station is proposed as the core area, designated as "Mixed-Use" with high density. This means high-rise buildings, including residential apartments, offices, retail/commercial spaces, and hotels, can be constructed within a single development plot.

The reallocation of zoning should be carried out until the proportions align with the benchmark values observed in the TOD Benchmark areas. By implementing these changes, the Fatmawati TOD area is expected to achieve outcomes more aligned with the TOD Benchmark and create a vibrant and integrated transit-oriented development. The following Table 4 and Figure 5 illustrate the simulation results of proposed changes to the land use area.

Table 4. Zoning proposal for TOD Fatmawati

No	Zoning	Land Area	
		Square meter	%
1	Residential	613,892.59	34.23
2	Office	274,395.46	15.30
3	Commercial + Hotel	255,385.06	14.24
4	Mixed-use	190,642.07	10.63
5	Public facilities	349,540.36	19.49
6	Green open space	109,399.50	6.10
	Total	1,793,255.04	100.0

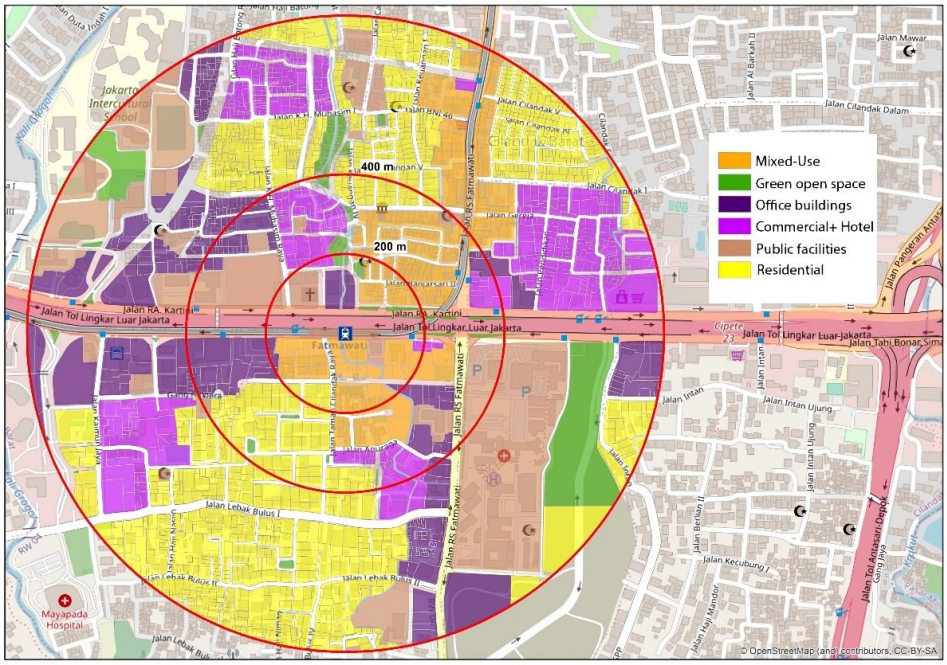

Figure 5. The proposed land use map for Fatmawati TOD

The land use composition underwent significant changes in the redevelopment process. The residential area proportion decreased from 57.6% to 34.23%, while the office space expanded from its initial 10.4% to 15.30%. The commercial and hotel zone witnessed substantial growth, increasing from a mere 8.6% to 14.24%. Notably, the mixed-use area experienced a remarkable transformation, expanding from a mere 0.7% to an impressive 10.63%. Meanwhile, the public facilities portion saw a modest increase, rising from 17.6% to 19.49%. Lastly, the green open space saw a slight rise from 5.2% to 6.1%. These changes reflect a deliberate effort to optimize land usage, accommodating diverse functions and fostering a more vibrant and sustainable environment in the redeveloped area. However, it is essential to acknowledge that the land area percentages in the Fatmawati TOD do not fully align with the TOD Benchmark. This discrepancy is attributed to certain constraints and limitations that hindered the complete alteration of built-up areas. These pre-existing structures and developments within the TOD area may have posed technical, legal, or financial challenges, making it impossible to match the TOD Benchmark. Despite this, the redevelopment efforts still aimed to optimize land use to the best extent possible, considering the existing constraints, to create a more efficient and sustainable transit-oriented development.

3.2. Land Readjustment Model Scheme

Based on the literature study, it can be concluded that there are four phases in the LR process (see Figure 6): the Initiation Phase, the Planning Phase, the Execution Phase, and the Monitoring Phase.

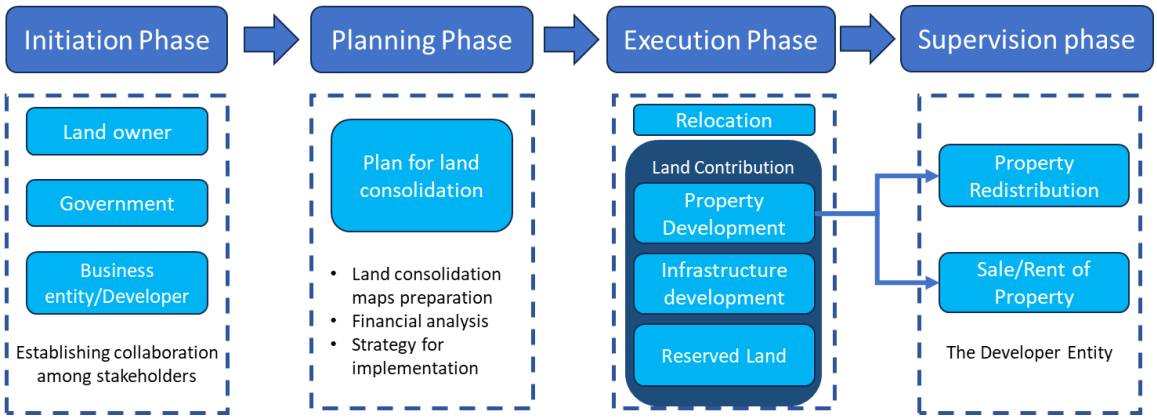

Figure 6. Schematic of the land readjustment model

Initiation Phase: In this phase, landowners can collaborate with the government and private entities (private developers) to establish a new entity responsible for developing the TOD area. The purpose of forming this partnership is to ensure mutual benefits among stakeholders [32]. According to Kidokoro [48], one form of collaboration that can be applied is Public-Private Partnership (PPP). This method has been successfully used in developing the Otemachi-Marunouchi-Yurakucho (OMY) area, a 120-hectare site near Tokyo Station, Japan. The process began with the establishment of the OMY Redevelopment Project Council, which brought together property owners to discuss the future growth direction of the city. Once the property owners reached a basic agreement, the Tokyo Metropolitan Government and JR East Railway Company joined forces with the Project Council to form the OMY Area Development Advisory Committee as a form of PPP. This committee then issued Urban Design Guidelines that established the long-term vision for the area and the development rules that property owners must adhere to.

Planning Phase: According to Schrock [33], LR planning involves the following processes: mapping of existing land use, simulation of proposed new land use mapping including land contributions for public facilities, land contributions for reserved areas, and the consolidated land block; financial analysis considering project construction costs, land readjustment costs, and potential property revenues; and property distribution schemes for original landowners. Large and irregularly shaped land parcels are merged into a new consolidated block during replotting. A portion of the land is allocated for public facilities (road widening) and government-controlled reserved areas. Financial analysis is conducted on the TOD area development simulation, and the outcomes are the NPV and IRR values, which serve as financial indicators.

Execution Phase: According to Supriatna [32], landowners/occupants participating in the consolidation process temporarily relocated during construction. During this relocation, they should receive compensation for losing their residence/business. Based on Schrock [33], the collected land will be allocated to develop infrastructure/public facilities, reserved areas, and new property construction.

Monitoring Phase: The distribution of properties to the original landowners is an important aspect of LR, considering that the principle of LR is not to displace the original landowners and to return them to their original land location once the LR process is completed [32].

3.3. Proposed Land Readjustment

Based on the data presented in Figure 5 and Table 4, a simulation of the LR model was conducted. The simulation resulted in the proposed LR map for the Fatmawati TOD, as shown in Figure 7. The simulation included various interventions to the existing land use map depicted in Figure 5 and Table 4. Firstly, irregularly shaped and sized land parcels were consolidated into a single block with a unified function. The ownership of the new block of land will be shared among the original landowners.

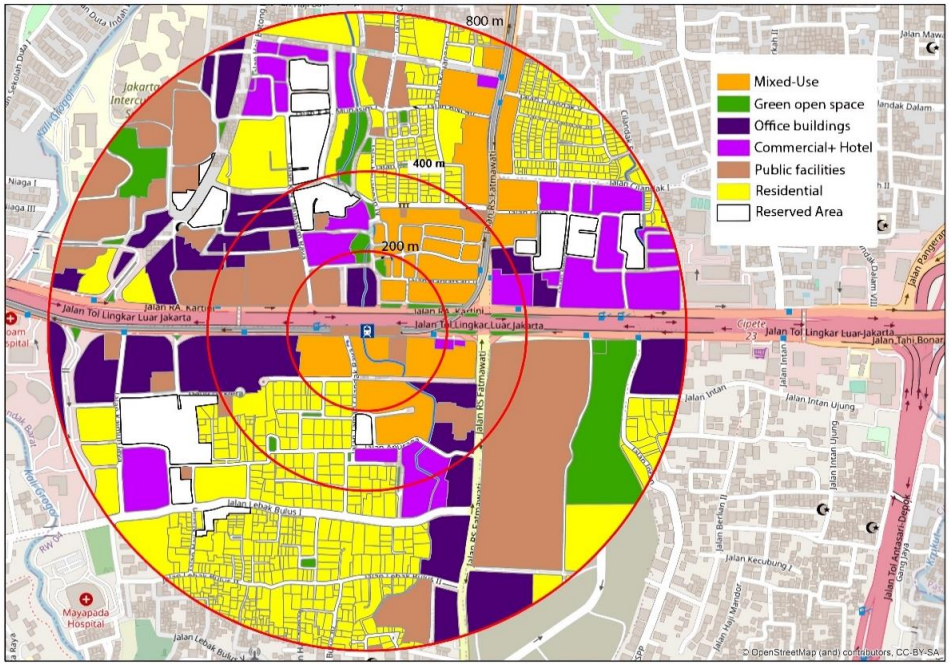

Figure 7. Land readjustment map

Secondly, certain land blocks are designated as reserved areas, where the original landowners transfer their ownership rights to the government. The government subsequently manages these reserved areas, which can be sold or developed as the area's development project advances, aiming to cover the associated costs.

Thirdly, designing the area within a radius of 0-400 meters from the station as the core area, focusing on mixed-use, office, and commercial zoning. Meanwhile, the area within a radius of 400-800 meters from the station is designated as the secondary area, accommodating residential, office, commercial, and mixed-use functions. The core area has a FAR of 7.42, while the secondary area has a FAR of 5. This means land parcels closer to the station have a higher building than those farther away.

Fourthly, the TOD area's development strategy includes infill sites (developing vacant land) and redevelopment (rebuilding existing land). Therefore, information about the distribution of vacant land locations becomes crucial input for the planning process.

Figure 7 offers insightful details regarding the specific areas in the Fatmawati TOD that underwent consolidation, zoning changes, road widening, or new road construction and became reserved areas. The distinguishing feature between Figure 7 and Figure 5 is the presence of reserved areas represented by white-colored blocks. Additionally, upon closer inspection of some blocks, individual land parcels have been consolidated into one block, eliminating the parcel boundaries. In addition, Table 5 provides an overview of the zoning classifications within the LR model, including residential, office, commercial, mixed-use, public facilities, green open spaces, reserved areas, and road widening contributions. The last two categories, namely reserved areas and road widening contributions, are the outcomes of the LR simulation process. Incorporating reserved areas and consolidating land parcels into larger blocks are significant changes in the LR process, leading to a more integrated and streamlined development layout in the TOD project. These modifications reflect a more comprehensive approach to optimize land use and accommodate the planned infrastructure and facilities within the TOD area.

The proportion of residential land, amounting to 28.61%, falls within the acceptable range of the ideal residential area for Transit-Oriented Development (TOD), which is set between 24% to 56% of the total area. Similarly, the percentages for office and commercial + hotel areas are 12.92% and 8.57%, respectively, both falling within the prescribed ideal ranges of 6% to 24% for office and 8% to 34% for commercial zones [39].

Table 5. Details of land use allocation on land readjustment map

Zoning	Land Area	
	Square meter	%
Residential	509,484.14	28.61%
Office	230,043.57	12.92%
Commercial + Hotel	152,558.28	8.57%
Mixed-use	162,920.90	9.15%
Public facilities	304,322.87	17.09%
Green open space	95,305.67	5.35%
Reserved Area	106,640.48	5.99%
Road widening and new road construction	219,668.35	12.33%
Total	1,780,944.29	100%

Additionally, the reserved area accounts for 5.99% of the total area, while the road widening contributions constitute 12.33%, both of which align closely with the distribution of land allocated for sale or land bank (7.8%) and land allocated for roads (14.2%) in the 103 LR plans of the Ahmedabad Urban Development Authority (AUDA) spanning from 2002 to 2010 [49]. However, when compared to the LR project around Kashinawanoha Campus Station on Tsukuba Express, where 13.55% is allocated for reserved land and 26.45% for public use [50], the allocation in the Fatmawati TOD project falls short of expectations. Allocating sufficient space for reserved areas and public use is crucial for creating a well-balanced and sustainable development. Properly designed reserved areas and public-use spaces contribute to the overall livability and functionality of the TOD, attracting more residents and businesses while enhancing the value of the properties. Therefore, further examination and adjustments may be necessary to optimize land allocation in the TOD project to meet the objectives and standards set forth by successful LR projects, like the one around Kashinawanoha Campus Station.

Furthermore, block consolidation in the Fatmawati TOD has led to changes in land parcels, resulting in the determination of new land areas and their respective ratios to the total area for each zoning category.

3.4. Land Readjustment Feasibility

The area of land that undergoes consolidation will serve as the basis for financial feasibility analysis. Table 6 provides detailed information on the land areas used, an expansion of Table 5. Using ArcGIS software, data is obtained regarding the individual land parcels that undergo consolidation through LR simulation and map creation. This includes land parcels merged into multiple blocks, land parcels reduced or lost due to road widening or infrastructure development, and land parcels designated as reserved areas. The three categories of land parcels were recalculated for their respective areas using the Calculate Geometry feature in ArcGIS. This consolidation simulation divides the planning area into two categories: Core Area and Secondary Area. The zoning for each area is the same, distinguishing only the allocation of land area and FAR.

The total area that underwent consolidation is 102.5 hectares, which accounts for 57% of the total area of Fatmawati TOD. The Gross Floor Area is determined based on the land area of each property and the respective Floor Area Ratio (FAR), which is 7.42 for the core area and 5 for the secondary area. According to architectural standards [51], each type of structure has a specific effective space, representing the percentage of the area that can be utilized as a living space. We can calculate the Net Area by multiplying the Gross Floor Area by the effective space percentage. This calculation considers the actual usable area of a building, considering factors such as walls, columns, and other non-usable spaces.

The Redistributed Area refers to the floor area of buildings returned to the original landowners as compensation for their relocated structures. The return of property area to the original owners follows the principle of relative size commonly used in Germany. Landowners will receive their land back in the same area as the original land, minus the land contribution [33]. On the other hand, the Saleable Area refers to the floor area of buildings that the developer can sell to generate profit. It is obtained by subtracting the Net Area from the Redistributed Area.

3.4.1. Financial Analysis

The cash flow calculation assumes a construction period of three (3) years and an operational lifespan of 30 years. The cash flow calculation aggregates the initial cost, operating, maintenance (OM), and revenue (see Table 7). The initial cost includes construction, demolition, and LR costs. Construction costs are calculated based on the base cost data from the 2019 Cost Construction Handbook Indonesia, published by Arcadis [52], to ensure that the construction cost estimation is based on reliable and up-to-date industry standards, enhancing the accuracy of the overall budgeting process. The construction costs are specific to each type of building or facility within the project area. For instance, the construction cost for apartments is estimated at 12.8 million rupiah per square meter; for office buildings, it is 12.5 million rupiah per square meter; for retail malls, it is 11.7 million rupiah per square meter; for hotels it is 22.6 million

rupiah per square meter, for roads it is 3.1 million rupiah per square meter, and for green open spaces it is 1.5 million rupiah per square meter. These costs include materials, labor, equipment, and other expenses required to construct apartments, commercial buildings, offices, hotels, and other structures within the TOD area. Demolition costs for the project are determined based on the prevailing market prices in Jakarta in 2020, which amount to 107.2 thousand rupiah per square meter. Demolition costs account for expenses related to the safe and efficient removal of existing structures. These costs are influenced by the prevailing market prices in Jakarta in 2020, as local market conditions can significantly impact demolition services and materials costs.

Table 6. Calculation of land area for financial analysis

Zoning	Land Area (sqm)	Gross Floor Area (sqm)	Effective Space (%)	Net Area (sqm)	Redistributed Area (sqm)	Saleable Area (sqm)
Core Area						
1. Residential	8,971.14	66,565.83	80%	53,252.66	48,337.52	4,915.14
2. Office	94,140.03	698,519.02	85%	593,741.17	18,526.86	575,214.30
3. Commercial	44,089.68	327,145.40	90%	294,430.86	15,941.79	278,489.07
4. Mixed-use	114,722.41	851,240.28				
a. Residential	-	204,297.67	80%	163,438.13	48,337.52	115,100.61
b. Office	-	204,297.67	85%	173,653.02	-	173,653.02
c. Commercial	-	212,810.07	90%	191,529.06	-	191,529.06
d. Hotel	-	127,686.04	85%	108,533.14	-	108,533.14
e. Others	-	102,148.83	-	-	-	-
5. Reserved Area	15,366.67	-	-	-	-	-
Secondary Area						
1. Residential	115,731.23	578,656.14	80%	462,924.91	238,560.786	224,364.13
2. Office	100,354.28	501,771.41	85%	426,505.70	15,701.56	410,804.14
3. Commercial	77,219.33	386,096.64	90%	347,486.97	39,073.363	308,413.61
4. Mixed-use	48,198.50	240,992.48				
a. Residential	-	57,838.20	80%	46,270.56	-	46,270.56
b. Office	-	57,838.20	85%	49,162.47	-	49,162.47
c. Commercial	-	60,248.12	90%	54,223.31	-	54,223.31
d. Hotel	-	36,148.87	85%	30,726.54	-	30,726.54
e. Others	-	28,919.10	-	-	-	-
5. Reserved Area	91,273.82	-	-	-	-	-
Road	219,668.35	-	-	-	-	-
Green open space	95,305.68	-	-	-	-	-
Total	**1,025,041.10**					

Table 7. Life cycle cost analysis

The Cash Flow Statement	Total (IDR Billion)*
Initial Cost	**54,320.94**
• Demolition cost	45.53
• Relocation Cost	5,810.89
• Administrative Costs for Land Readjustment	1.05
• Construction Cost for Property	47,545.59
• Construction Cost for Road and Green open space	917.88
Operation and Maintenance Cost per Year	**1,882.46**
• Residential/Apartment	187.98
• Office	443.34
• Commercial	522.26
• Mixed-use	721.23
• Road	5.77
• Green open space	1.88
Revenue	**17,458.98**
• Sales	7,937.55
• Rent (first-year)	7,703.08
• Service Charge (first-year)	1,818.35

* 1000 IDR = 0.063 USD

According to Supriatna [32], the cost of LR should include compensation for demolished buildings and temporary relocation expenses for the original landowners during the construction period. Since demolition costs are calculated separately, the LR cost only includes relocation and administrative costs. On the other hand, the annual operating and maintenance (OM) costs are calculated as 2% of the construction costs [44]. Calculating the OM costs as 2% of the construction costs provides a straightforward and proportionate method for estimating the annual expenses required for the operation and maintenance of the transit-oriented development (TOD) project. By using a fixed percentage of the construction costs, the OM costs automatically scale with the size and complexity of the project. This approach ensures that the OM budget aligns with the scale of the development, avoiding underestimation or overestimation of the operational expenses.

The revenue calculation is based on the Saleable Area, property prices, occupancy rate, annual rental rate increase, service charge rate increase, and the coefficient of Hedonic Price Modelling (HPM) [44]. Including the HPM coefficient is important because the property's proximity to the transit station (MRT) significantly impacts property prices [47] .

In the core area of the TOD project, the property prices are as follows: Apartments have a selling price of 23.8 million rupiah per square meter, and they can also be leased at a rate of 383.7 thousand rupiah per square meter per month. For office spaces, the lease rate is 265.4 thousand rupiah per square meter per month. Retail or commercial spaces are available for rent at a rate of 454.8 thousand rupiah per square meter per month. The hotel accommodation is offered at a rate of 794.4 thousand rupiah per unit per night. Comparatively, in the secondary area of the TOD project, the property prices are as follows: Apartments have a selling price of 23.1 million rupiah per square meter, and they can also be leased at a rate of 372.2 thousand rupiah per square meter per month. Office spaces in the secondary area can be leased at a rate of 267.8 thousand rupiah per square meter per month, similar to the core area. Retail or commercial spaces are also available for rent at the same rate of 454.8 thousand rupiah per square meter per month as in the core area. The hotel accommodation remains consistent at a rate of 794.4 thousand rupiah per unit per night.

Based on the financial analysis, the TOD Fatmawati area has a Net Present Value (NPV) of IDR 125 trillion and an Internal Rate of Return (IRR) of 15.94%. The Minimum Attractive Rate of Return (MARR) for most infrastructure investment projects in Indonesia is around 12% [44]. Therefore, the TOD development project with an LR scheme can be considered financially viable based on a positive NPV of IDR 125 trillion and an IRR of 15.94% (above the MARR).

Concerning the potential value of the Reserved Area, as indicated in Table 5, the TOD project encompasses a total of 106,640.48 square meters or 10.66 hectares of reserved area. This presents a potential cost equivalent land value of IDR 1.06 trillion, based on the land price before the readjustment process. However, the overall cost of LR, inclusive of expenses for relocation, administration, demolition, road construction and widening, as well as green space development, amounts to 6.7 trillion rupiah. As a result, the value of the Reserved Area can only cover 16% of the total LR Costs. This percentage is notably lower when compared to the LR projects in Kashinawanoha Campus Station and Yokohama MM21 waterfront development project. In Kashinawanoha, the project costs of ¥96.3 billion ($891 million) were largely recovered from sales of reserved land parcels, approximately ¥60.9 billion ($563 million, 63.2 percent). Similarly, in Yokohama, the land premiums to be shared were estimated at ¥74 billion ($578 million), accounting for nearly 29 percent of the project costs [50]. The substantial discrepancies in the financial performance between the Fatmawati TOD project and the aforementioned LR projects underscore the need for further analysis and strategies to enhance the financial feasibility and effectiveness of the LR process in the TOD context.

Given the significant relocation costs amounting to IDR 5.8 trillion, as proposed by Supriatna [32] the government should consider utilizing existing apartment buildings near the TOD project as temporary relocation sites. This approach seeks to alleviate the financial burden associated with relocation expenses while optimizing the utilization of available resources effectively. Such measures can potentially reduce costs and improve the overall financial viability of the TOD project.

3.4.2. Redistribution of Property

The principle of LR aims to avoid displacing the original landowner from their property. Therefore, during the construction period, the owners of the relocated properties will have the opportunity to reclaim their land. There are four property return or redistribution scenarios in LR: shares in landholding entities, ground leases, profit sharing, and outright sale. These scenarios provide various options for the landowners to regain control or benefit from their properties within the LR framework [53].

Shares in Landholding Entity is a scenario where landowners form an association that collectively owns the consolidated land. Each original landowner holds a proportional share of the association's shares based on the size of their respective land before readjustment. In this scenario, landowners receive apartment, office, or commercial space in exchange for their demolished buildings and retain partial ownership of the land on which the new buildings are constructed. There is no recurring income for the landowners in this scenario.

Ground Lease is a scenario where the landowners' association enters into a lease agreement with a developer for a specified period (long-term lease). The landowners' association receives lease payments from the developer, which are paid annually and determined based on the Initial Land Value and the Ground Lease Cap Rate. The lease payments are then evenly distributed among the landowners according to their proportional shares in the collective land.

Profit Sharing is a scenario where the landowners' association receives a portion of the rental income generated from the property by the developer. The percentage of profit sharing for the landowners' association is determined based on the proportion of the Initial Land Value to the total initial project cost (Initial Cost). The rental income from the property depends on the developer's performance.

Outright Sale is a scenario where landowners choose not to participate in the LR. Instead, the developer acquires the land through conventional means. The developer compensates the landowners by paying them the market value of the land and any existing structures. In return, the landowners transfer the ownership rights of the land to the developer.

A property redistribution simulation is conducted using the four scenarios mentioned above for a specific block in the Fatmawati TOD area to assess the impact on the project feasibility. This block (Figure 8-a) comprises several residential and office plots with existing buildings. After the LR process (Figure 8-b), these plots are merged into one, and the zoning is converted to mixed-use, allowing the construction of apartments, offices, commercial spaces, and hotels on the same block, with a maximum FAR of 7.42.

(a) (b)

Figure 8. Block simulation of property redistribution

In this simulation, there are eleven land/plot owners, with the majority of the plots being residential (yellow box), while three plots are for office use (purple box). The Land Area Existing and Floor Area Existing serve as the basis for calculating the initial land value and relocation costs. The ownership percentage is calculated based on the area of each plot in relation to the total block area. A portion of the land is allocated for road widening as a land contribution. However, no land is allocated as reserved land. By subtracting the land contribution from the Land Area Existing, we obtain the adjusted land area. This area will determine the income for the landowners in the collaboration scheme with the developer (see Table 8).

Table 8. Land Area for Redistribution of property simulation

Landowner	Land Area Existing (sqm)	Floor area existing (sqm)	Ownership (%)	Land Contribution (sqm)	Adjusted Land Area (sqm)
A	427.99	45.00	11.76	34.96	393.03
B	526.54	352.00	14.47	121.44	405.10
C	157.94	124.00	4.34	13.58	144.36
D	223.22	169.00	6.13	17.96	205.26
E	379.37	172.00	10.42	87.88	291.50
F	70.39	-	1.93	6.34	64.06
G	301.44	189.00	8.28	28.82	272.62
H	313.89	211.00	8.63	26.78	287.11
I	342.59	306.00	9.41	83.92	258.67
J	491.30	354.00	13.50	39.85	451.45
K	404.49	-	11.11	127.84	276.65
Total	**3,639.16**	**1,922.00**		**589.36**	**3,049.79**

The four schemes have different impacts on property revenues, as indicated by the variations in NVP and IRR values (see Table 9). In scheme one (shares in landholding entity), there is no mechanism for providing property income to the landowners. In this case, the landowners only receive compensation for temporary relocation costs. As a result, the property income (sales/rental) belongs entirely to the developer, leading to an IRR of 16% and an NPV of IDR 756 billion for the developer.

Table 9. Impact of redistribution schemes on NPV and IRR

	Shares in Landholding Entity	Ground Lease	Profit Sharing	Outright sale
IRR	16%	14,5%	13,4%	17,5%
NPV	IDR 756 billion	IDR 653 billion	IDR 567 billion	IDR 1.06 trillion

In scheme two (ground lease), the landowners receive income in the form of land lease payments made by the developer on an annual basis. This increases the operational burden for the developer, resulting in a decrease in NPV and IRR values to IDR 653 billion and 14.5%, respectively. In scheme three (profit sharing), the landowners receive a share of the developer's property income but do not receive annual land lease payments. The impact is that the portion of property income for the developer is reduced as they have to share it with the landowners. As a result, the NPV and IRR values decrease further to the lowest among the previous schemes, amounting to IDR 567 billion and 13.4%.

Meanwhile, the fourth scheme provides the largest financial benefit to the developer with an NPV of IDR 1.06 trillion and an IRR of 17.5%, despite incurring additional land acquisition costs in the initial cost amounting to IDR 86.9 billion. The significant revenue in this scheme is due to several factors: all building floors can be sold/leased by the developer, there are no land lease costs, and no sharing of income is required.

Based on the comparison of these four schemes, it can be observed that as the benefits for landowners increase, the NPV and IRR values for the developer tend to decrease. This is because the more benefits and revenue sharing provided to the landowners, the lower the net income for the developer. Consequently, the project's profitability decreases as measured by NPV and IRR. It is important to carefully evaluate and balance the benefits for landowners and the financial feasibility for the developer to ensure a successful and sustainable project outcome.

Furthermore, LR's impact on landowners' asset value can be demonstrated. This can serve as a consideration for landowners to participate or not in the readjustment process. The initial asset value of landowners is calculated based on the land price before LR was implemented. In contrast, the building price is based on the assumption of construction costs for residential houses/landed houses. On the other hand, the Consolidated Asset Value is calculated based on the land price after readjustment, assuming an increase of up to 33% (De Souza et al. [17]), and the building price is based on the assumption of construction costs for apartments. From Table 10, it can be seen that, on average, participating landowners in the readjustment process will experience a 22% increase in asset value and have the potential to receive additional income from cooperation with developers, averaging IDR 324 million per year (ground lease) or IDR 582 million per year (profit sharing).

Table 10. The impact of the redistribution scheme on asset value

Landowner	Initial asset value (IDR Million)		Consolidated Asset Value (IDR Million)		Recurring Income (IDR Million)	
	Land Value	Building Value	Land Value	Building Value	Ground Lease	Profit Sharing
A	8,559	332	10,454	579	419	754
B	10,530	2,598	10,775	4,534	516	927
C	3,158	915	3,839	1,597	154	278
D	4,464	1,247	5,459	2,176	218	393
E	7,587	1,269	7,753	2,215	371	668
F	1,407	-	1,703	-	68	124
G	6,028	1,395	7,251	2,434	295	531
H	6,277	1,557	7,637	2,717	307	552
I	6,851	2,258	6,880	3,941	335	603
J	9,826	2,613	12,008	4,559	481	865
K	8,089	-	7,358	-	396	712
Average					**23.64**	**582.45**

4. Conclusion

TOD projects are gaining recognition as a crucial component of sustainable urban planning. By promoting efficient land use and minimizing dependency on private vehicles, TOD projects hold the potential to alleviate traffic congestion, reduce carbon emissions, and improve overall urban quality. However, implementing TOD projects often confronts various challenges, one of which is with regard to land acquisition and redistribution. This research addresses these challenges within the context of the MRT Jakarta project, proposing an LR approach as a potential solution.

The results of the study revealed significant differences between the existing land use in the Fatmawati TOD area and the ideal TOD model. It indicated that the distribution of office and commercial areas is still not optimal yet, necessitating adjustment to achieve better land use diversity and economic vibrancy. Furthermore, the financial analysis conducted revealed positive feasibility for the TOD project, demonstrating a favorable NPV and IRR. The TOD Fatmawati area specifically exhibited a financially viable NPV of IDR 125 trillion and an IRR of 15.94%. Nevertheless, it is worth noting that the total LR costs, encompassing relocation, administration, demolition, road construction, and widening, as well as green space development, amounted to 6.7 trillion rupiah, while the potential value of the Reserved Area, estimated at IDR 1.06 trillion based on the land price before the readjustment process, only covered 16% of the total LR costs.

Therefore, the study proposes a solution that involves leveraging existing apartment buildings near the TOD project as temporary relocation sites. By adopting this approach, the project can optimize available resources and significantly reduce the financial burden associated with relocation expenses. Furthermore, this research also explored different property redistribution scenarios, assessing their impacts on property revenues and overall project feasibility. Striking a balance between landowners' benefits and the developer's financial feasibility is essential for a successful and sustainable TOD project. The fourth scheme, which provided the largest financial benefit to the developer, proved to be the most financially viable.

While this research undertook a thorough analysis, several areas for future research can further enhance the understanding and effectiveness of TOD projects. Additionally, comparative studies between different LR projects in various cities and countries can offer valuable insights into the effectiveness of different LR approaches and their impact on project outcomes. Learning from successful LR projects can inform best practices and strategies to improve the implementation and outcomes of TOD developments. Furthermore, exploring innovative implementation strategies for TOD projects, such as public-private partnerships and community engagement models, can provide guidance for more effective project execution. Embracing creative approaches to involve various stakeholders can enhance the project's acceptance and alignment with community needs and aspirations. Through deeper investigation into these research areas, future studies can contribute to the continuous improvement and advancement of TOD projects, realizing the full potential of TOD projects and shaping the future of urban development.

5. Declarations

5.1. Author Contributions

Conceptualization, G.S. and M.A.B.; methodology, G.S. and D.S.; software, D.S. and M.S.; validation, G.S., M.A.B., B.S., and R.W.; formal analysis, G.S. and D.S.; investigation, D.S.; resources, M.S.; data curation, D.S.; writing—original draft preparation, G.S. and M.S.; writing—review and editing, M.A.B. and M.S.; visualization, M.S.; supervision, M.A.B., B.S., and R.W.; project administration, M.S.; funding acquisition, G.S. and M.S. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

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None.

5.5. Conflicts of Interest

The authors declare no conflict of interest.

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