Planned Unit Development (PUD) in Urban Design Project
มาตรการโครงการขนาดใหญ่ในการออกแบบชุมชนเมือง

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Abstract

Since 1960s Bangkok has been under the practices of post-war urban planning, in addition to a series of initial development of comprehensive plans, through four versions of adopted comprehensive plans which were used as urban development controlling tool, while lacking regulations for urban guidance. Planned Unit Development (PUD) is a regulation allowing comprehensive planning and design on a specific large urban area with flexibility for greater livability. This research aims to explore the applicability of PUD in the urban development process of Bangkok. Two conceptual design scenarios for applying PUD were generated providing project feasibility analysis and PUD design guidelines. The research is conducted as an experimental study focusing on the tasks of three variables: scenario generation, feasibility analysis, and urban design and development. The design experimentation result has been stated that it potentially applies PUD on the study site (Pahonyothin 19/1, Bangkok). However, it will require great financial aid and a period of time. With PUD, Bangkok urbanization can reach the stage of urban design that contributes variable benefits such as site planning and design, density modification, providing infrastructures, and circulation improvement. In addition, PUD provides greater ranges of benefits such as carbon reduction, urban heat island mitigation, promoting Transit Oriented Development (TOD), and positioning on SDG 11: Sustainable Cities and Communities. The research output is providing guidelines towards a sustainable 21st century city for Bangkok.

Keywords

Planned Unit Development (PUD)

Urban Design

Financial and Feasibility Analysis

Mixed-use Development

บทคัดย่อ

กรุงเทพมหานครได้มีการพัฒนาผังเมืองรวมตั้งแต่ปี พ.ศ. 2503 ผ่านผังการศึกษาการใช้ประโยชน์ของเมือง และ 4 ผังบังคับใช้ ซึ่งผังบังคับใช้นั้นยังขาดกฎหมายบังคับใช้ในเรื่องของแนวทางในการออกแบบ มาตรการโครงการขนาดใหญ่ หรือ Planned Unit Development (PUD) นั้นเป็นเครื่องมือกฎหมายทางด้านผังเมืองที่มีศักยภาพในการวางผังและออกแบบพื้นที่ชุมชนเมืองขนาดใหญ่ งานวิจัยนี้มีวัตถุประสงค์เพื่อที่จะศึกษาการบังคับใช้มาตรการโครงการขนาดใหญ่ในระบบการพัฒนาเมืองของกรุงเทพมหานครด้วยการออกแบบ 2 สถานการณ์จำลองผ่านการจัดทำการศึกษาความเป็นไปได้ของโครงการและแนวทางการออกแบบในมาตรการโครงการขนาดใหญ่ งานวิจัยนี้เป็นงานวิจัยเชิงทดลองด้วยการศึกษาผ่าน 3 ตัวแปร คือ 1) สถานการณ์จำลอง 2) การศึกษาความเป็นไปได้ของโครงการ 3) การออกแบบและพัฒนาชุมชนเมือง ผลจากการวิจัยพบว่ามาตรการโครงการขนาดใหญ่นั้นสามารถนำไปใช้กับพื้นที่ศึกษา (พหลโยธิน 19/1) ได้ แต่ว่าโครงการจะต้องได้รับความช่วยเหลือทางการเงินที่ดีและระยะเวลาที่ยาวนาน ด้วยประโยชน์จากการใช้มาตรการโครงการขนาดใหญ่นั้น กรุงเทพมหานครสามารถที่จะเป็นเมืองที่สามารถเข้าถึงขั้นตอนของการออกแบบชุมชนเมืองได้และก่อให้เกิดประโยชน์ในการพัฒนาเมืองที่หลากหลายเช่น การวางผังและออกแบบ ความยืดหยุ่นในการจัดการความหนาแน่น จัดทำโครงสร้างพื้นฐาน และการปรับปรุงการเคลื่อนที่ นอกจากนี้มาตรการโครงการขนาดใหญ่ยังสามารถที่จะช่วยในเรื่องของการลดจำนวนคาร์บอนในเมือง การบรรเทาภาวะปรากฏการณ์เกาะความร้อน การส่งเสริมการพัฒนาพื้นที่รอบสถานีขนส่งมวลชน และวางตำแหน่งเมืองใน SDG 11: เมืองและถิ่นฐานมนุษย์อย่างยั่งยืน ผลลัพท์จากการวิจัยนี้ได้นำแนวคิดและแนวทางในการนำพากรุงเทพมหานครไปสู่การพัฒนาที่ยั่งยืน

คำสำคัญ
มาตรการพัฒนาโครงการขนาดใหญ่
การออกแบบชุมชนเมือง
การวางแผนเพื่ออสังหาริมทรัพย์
การพัฒนาแบบผสมผสาน

1. Introduction

Bangkok, one of the fastest-developing primate cities in the Southeast Asia Region, has been facing challenges of urban development since the period of the National Development Plan in the 1950s. Problems of traffic congestion, insufficiency of infrastructures, and lack of livability of places have become considerable challenges for the development of the city.

Chronic traffic congestion of Bangkok has morphed since the national development period between 1958 – 1971, where the city changed from canal-based city to road-based city in order to support vehicle mobility. New road developments and an increase in automobile dependency are the consequences. By 1987, land expropriation legislation established the only objective to alleviate traffic congestion through new infrastructure development intervention projects such as overpasses, elevated highways, and tollways. However, infrastructures for quality of life and well-being such as public spaces, health, and services security reflected the relentlessness of automobile dependency. Infrastructures such as roads and public spaces became insufficient, along with the problems of unpredicted traffic congestion and environmental deterioration (Askew, 2002).

At present, Bangkok's planning system relies mainly on the regulation of the base plan (comprehensive plan) in which the main objective is to control land uses. Other related regulations on building bulkiness, building height, building uses, set back surfaces and density also have to rely on the regulations of the plan. Despite the fact that Bangkok is a city that has rare opportunities to implement urban design; many places of new developments in Bangkok lack the livability of places in regards to urban character, urban diversity, and quality of well-being.

In order to resolve the problems of traffic congestion, insufficiency of infrastructures and the lack of spirit of place in Bangkok, the planning system must permit guidance opportunities for urban design. Planned Unit Development (PUD) is a regulatory process through a combination of land use zoning regulation and land subdivision regulation which has planning and design characters such as single ownership, negotiation between developer and government, mixture of land uses and building uses, infrastructure development, and development phasing (Sternlieb, Burchell, Hughes & Listokin, 1974).This study will introduce the PUD intervention to create a more livable urban setting for Bangkok.

2. Objectives of the Research

2.1 To explore the applicability (flexibility in modifying density) of PUD measures in the context of Bangkok's urban development process through design scenarios.

2.2 To provide project feasibility analysis for achieving the financial goal of property development through PUD transformation.

3. Research Methods

The study is conducted as exploratory research focusing on the tasks of three variables: scenario generation (design development scenario one and design development scenario two), feasibility analysis (Net Present Value analysis, Internal Rate of Return analysis and Payback period analysis) and urban design and development (site planning, circulation, building, and open space). Data of the three variable related tasks will be classified through three collecting methods: site investigating, graphic (mapping), and literature reviews. The collected data will be explained through three analytical methods: site analysis, SWOT analysis, and feasibility analysis.

The study generated two design scenarios which are the scenario with no application of PUD and the scenario with the application of PUD. The scenarios are different on designed programs which are the indicator to justify the flexibility of density

modification (be able to modify FAR within the project area due to owned by a single entity) in the PUD process.

The overall information will be interpreted in descriptive approach as shown in Table 1.

4. PUD Measures Implementation

The design project follows regulation control derived from Bangkok Comprehensive Plan 4th Revision (draft version) and PUD regulation (draft version) which is performed as a floating zone. Under the PUD regulation, land ownership must own by a single entity in order to create flexibility in the project management process. The PUD applies through consideration as follows: (Bangkok City Planning Department, 2018)

4.1 Land Use: According to PUD regulation (draft version), for high density residential land uses (R.13 – R.15) and commercial land use (C.1 – C.8), the project land area must be over 32,000 sq.m. Density (FAR and OSR) follows Bangkok Comprehensive Plan 4th Revision (draft version).

4.2 Urban Block Size: The maximum urban block size for the PUD project is at 0.016 sq.km. (16,000 sq.m.). the block must have at least 16.00 m. width on one side of the land area and adjacent to the public road. Right of Way (ROW) must be over 16.00 m. The proximity between a junction is 120.00 m. at the minimum and 200.00 m. at maximum.

4.3 Transportation Network: The main road must be over 6 lanes with right of way more than 30.00 m. The minor road must be over 4 lanes with right of way more than 16.00 m. The local road must be over 2 lanes with right of way more than 12.00 m. The pedestrian way must be 1.50 m. at a minimum.

4.4 Infrastructures: PUD project must reserve at least 5% of the total project area for infrastructures such as park (at least 25% for perennial trees), recreation, school and hospital and elderly care.

4.5 Design Programs: Following Bangkok's Comprehensive Plan 4th Revision (draft version), residential use has no limitation on building density and right of way. However, commercial, office and hotel programs have to follow density control, and right of way on its land uses.

Table 1 Research Framework and Related Methods

Variable Tasks	Research Framework						Interpretation Summary
	Data Collection Methods (Qualitative)			Analytical Methods			
	Site Reconnaissance	Graphics (mapping)	Literature Reviews	Context Analysis	SWOT Analysis	Feasibility Analysis	
1) Scenario Generation							Interpretation from scenario generation task
1.1) Design Development Scenario One	●	●	●	●	●	●	
1.2) Design Development Scenario Two	●	●	●	●	●	●	
2) Feasibility Analysis							Interpretation from feasibility analysis task
2.1) Net Present Value (NPV) Analysis						●	
2.2) Internal Rate of Return (IRR) Analysis						●	
2.3) Payback Period Analysis						●	
3) Urban Design Development							Interpretation from urban design and development task
3.1) Site Planning	●	●	●	●	●		
3.2) Circulation	●	●	●	●	●		
3.3) Building	●	●	●	●	●		
3.4) Open Space	●	●	●	●	●		

Source: Researcher, 2019

5. Planned Unit Development (PUD) Design Guidelines Application

The study brings controls and guidelines from different sources (PUD ordinance draft version, urban design and planning standards, and Bangkok comprehensive plan 4th revision draft version) in order to apply for the design scenarios' criteria. The guidelines will be applied to the PUD project focusing on three main variables: site planning, circulation and building through seven design considerations: zoning, dimension, mobility, activities, visualization, amenities, and plantation as shown in table 2 (Bangkok City Planning Department, 2018; The Association of Siamese Architects, 2017; American Planning Association, 2006).

6. Legal Permissibility and Physical Possibility

The project area is located in Pahonyothin 19/1, Bangkok, Thailand. The area is divided into 5 plots which revel potential and possibility of land use and density modification according to Planned Unit Development (PUD) as depicted in Figure 1.

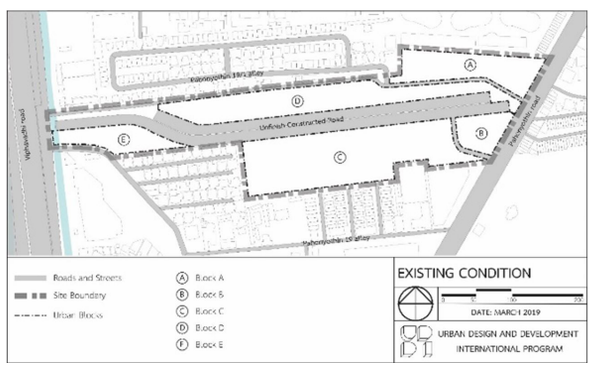

Figure 1 Pahonyothin 19/1 Project Land Plot Subdivision

Table 2 PUD Design Guidelines Checklist

Design Variables	Control Ordinances and Guidelines	Design Considerations					
		Zoning	Dimension	Mobility	Activities	Amenities	Vegetation
1) Site Planning							
Block Size	PUD ordinance, Urban planning and design standards		120m. – 200m.				
Street Spacing			120m. – 800m.				
2) Circulation							
Main Road	PUD ordinance Urban planning and design standards,		>6 lanes/ ROW>30.0m.	Deliver traffic from smaller roads to freeways or expressways	Auto-mobile flows and cross-walk	Median, traffic sign, lighting, crosswalk	Perennial plants and ornamental plants
Minor Road			>4 lanes/ ROW>16.0m.	Transports the most vehicle travels through city's commercial and institutional uses	Auto-mobile flows and cross-walk	Traffic sign, lighting, crosswalk	Perennial plants and ornamental plants
Local Road			>2 lanes/ ROW>12.0m.	Provide travel services in short distance	Auto-mobile flows and cross-walk	Traffic sign, lighting, crosswalk	Perennial plants and ornamental plants
Pedestrian Route		Shop front zone, walking zone, cycling zone, street furniture zone and vegetation zone	1.5m. width at minimum	Provide travel services for walking and cycling	Relationship between first level of the structure and horizontal space between the structure	Special paving, seating	Perennial plants and ornamental plants
3) Building							
Volume/ Massing	Bangkok comprehensive plan 4th revision (draft version)		Following land use control and PUD measures			Street wall, arcade, canopy, awning	Green Roof Top, green wall,

Source: Researcher, 2019

Following Bangkok's Comprehensive plan 4th revision (draft version), the project is located on high density residential land use (R.13) with FAR 7:1 and OSR 4.5%. The total land area on the existing condition is 76,800 sq.m. While the maximum development area with FAR 7 is at 537,600 sq.m. Along with the PUD measures, development's density can be modified flexibly within the development area as shown in Table 3.

Table 3 Existing Land Use and Density Modification Possibility (PUD Measures): Pahonyothin 19/1 Project

BLOCKS	LAND USE	FAR	OSR	EXISTING CONDITION GROSS AREA	MAXIMUM DEVELOPABLE FLOOR AREA
A	R.13	7:1	4.5%	9,000 sq.m.	63,000 sq.m.
B	R.13	7:1	4.5%	3,400 sq.m.	23,800 sq.m.
C	R.13	7:1	4.5%	22,200 sq.m.	155,400 sq.m.
D	R.13	7:1	4.5%	16,200 sq.m.	113,400 sq.m.
E	R.13	7:1	4.5%	5,400 sq.m.	37,800 sq.m.
PRIVATE ROADS	R.13	7:1	4.5%	20,600 sq.m.	144,200 sq.m.
TOTAL	-	-	-	76,800 sq.m.	537,600 sq.m.

Source: Researcher, 2019

7. Design Development Scenario One: Based on the Existing Condition

The design scenario one is based on the existing context (Pahonyothin 19/1) following Bangkok comprehensive plan 4th revision (draft version), the land area is located on high density land use (R.13) which regulated by land use control. The project has divided the land area into nine plots for development projects.

The existing infrastructure (internal constructed road, 4 lanes) is connecting between two main roads (Pahonyothin road and Viphavadhi road). It will help to alleviate the area's traffic congestion by delivering traffic flows from one road to another. However, the project does not minimize car dependency in order to promote pedestrianization as depicted in Figures 2 and 3.

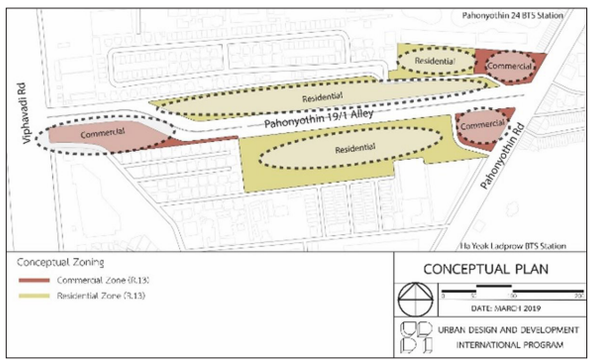

Figure 2 Design Scenario One: Conceptual Plan

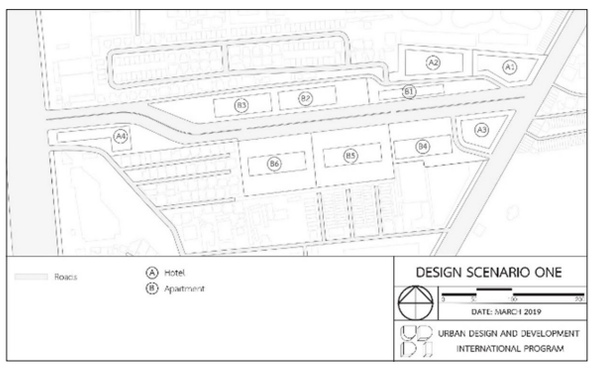

Figure 3 Design Scenario One: without PUD measure application

Regarding the project feasibility analysis of 30 years leasehold, the design scenario one has varied ranges of NPV at the minimum rate of accepted IRR as shown in Table 4.

8. Design Development Scenario Two: Application of PUD Measures

The design scenario two is designated based on the existing context of Pahonyothin 19/1 with the application of Planned Unit Development (PUD) measures.

In regards to the feasibility analysis, incomes after discount, infrastructures (roads and open spaces) will be constructed in the first phase with no profit return. Apartments will have no profit return due to unaccepted financial revenue as shown in Table 5.

Following Bangkok's comprehensive plan 4th revision (draft version), the project land area is located on high density land use (R.13). PUD measures can modify the density up to R.15 within the project area.

Table 4 Design Scenario One: Project Evaluation

Land Uses	No.	Programs Design	Block Sizes	BCR	Open Spaces	FAR 7	NPV	IRR	Payback Period
			Sq.m.	Sq.m.	Sq.m.	Sq.m.	Baht	%	Years
Infrastructures (Phase One)	-	Private Roads	22,850	-	-	-	-	-	0
Residential (Phase Two)	B1	Apartment	3,700	1,100	2,600	7,700	-122,374,780	4.4	-
	B2	Apartment	10,400	2,000	6,400	14,000	-89,067,921	5.6	-
	B3	Apartment		2,000		14,000	-89,067,921	5.6	-
	B4	Apartment	5,900	2,000	3,900	14,000	-89,067,921	5.6	-
	B5	Apartment	8,400	2,000	6,400	14,000	-89,067,921	5.6	-
	B6	Apartment	7,900	2,000	5,900	14,000	-89,067,921	5.6	-
Commercial (Phase Three)	A1	Hotel	3,900	2,200	1,700	15,400	248,679,970	12.0	9.1
	A2	Hotel	4,700	3,400	1,300	23,800	363,922,999	13.0	8.5
	A3	Hotel	3,300	1,900	1,400	1,400	323,344,468	12.6	8.7
	A4	Hotel	5,750	1,900	3,850	3,850	486,358,848	14.6	7.7
Total	-	-	76,800	20,500	33,450	130,200	-	-	-

Source: Researcher, 2019

Table 5 Phasing Development: Design Development Scenario One

Phasing Development: Scenario One		Payback period (years) (average)	Q1	Q2	Q3		Q4	
			Year 0-4	Year 5-9	Year 10-14	Year 15-19	Year 20-24	Year 25-30
Infrastructures (Phase One)	Private Roads	0	●	-	-	-	-	-
Residential (Phase Two)	Apartments	-	-	-	-	-	-	-
Commercial (Phase Three)	Hotels	8.5	-	●	-	-	-	-

Source: Researcher, 2019

The project has divided the land area into ten plots for Residential projects (apartments), office buildings, hotels, and commercial. The commercial area will be modified the density from R.13 to R.15 in order to maximize building areas for subsidizing revenue for infrastructure development as depicted in Figure 4.

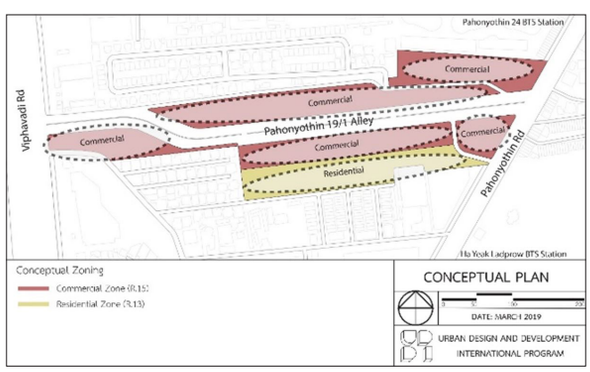

Figure 4 Design Scenario Two: Conceptual Plan

The design scenario two is built on new site planning with the application of PUD measures. The existing infrastructure has been remodeled in order to create the full potential to design the site. The Project is aimed to create mixed development through various design programs (residential, commercial, and infrastructures) as depicted in Figure 5.

Regarding the project feasibility analysis of 30 years leasehold the design scenario two has varied ranges of NPV at the minimum rate of accepted IRR as shown in Table 6.

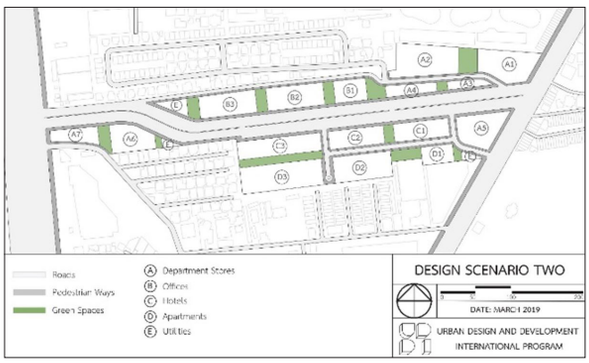

Figure 5 Design Scenario Two: With PUD Measures Application

Table 6 Design Scenario Two: Project Evaluation

Land Uses	No.	Programs Design	Area	FAR 7	FAR 8	NPV	IRR	Payback Period
			Sq.m.	Sq.m.	Sq.m.	Baht	%	Years
Infrastructures (Phase One)	-	Private Roads	24,350	-	-	-	-	0
	-	Park	6,400	-	-	-	-	0
	-	Pedestrian	8,900	-	-	-	-	0
	-	Utilities	1,000	-	-	-	-	0
Residential (Phase Two)	D1	Apartments	2,900	20,300	-	-24,986,304	7.9	-
	D2	Apartments	2,950	20,650	-	-24,986,304	7.9	-
	D3	Apartments	4,200	29,400	-	-102,897,085	5.1	-
Commercial (Phase Three)	A1	Department Store	3,200	-	25,600	60,282,370	11	10.76
	A2	Department Store	3,800	-	30,400	26,825,414	9	11.37
	A3	Department Store	600	-	4,800	55,405,730	9	10.96
	A4	Department Store	1,000	-	8,000	86,351,641	10	10.63
	A5	Department Store	2,600	-	20,800	47,599,080	10	10.81
	A6	Department Store	1,300	-	10,400	123,758,344	10	11.49
	A7	Department Store	2,000	-	16,000	125,028,117	11	10.08
	B1	Office	1,400	9,800	-	44,663,025	10	11.36
	B2	Office	2,500	17,500	-	59,078,009	10	10.89
	B3	Office	2,500	17,500	-	59,078,009	10	10.89
	C1	Hotel	2,000	14,000	-	399,632,107	13.3	8.37
	C2	Hotel	2,000	14,000	-	399,632,107	13.3	8.37
	C3	Hotel	1,200	8,400	-	248,679,970	12.0	9.17
Total	-	-	76,800	151,500	116,000	-	-	-

Source: Researcher, 2019

In regards to the feasibility analysis, incomes after a discount of all commercial design programs have been positive which will assure that the project development will be achieved in time. Infrastructures will be constructed in the first phase and have no profit return. The profit from phase two will assure further investment in residential development in the last phase as shown in Table 7.

Focusing on average of the result of financial indicators (NPV, IRR, and payback period) on both design scenarios, NPV of design scenario two is having more value than design scenario two at 98,946,514 baht to 85,459,190. IRR of design scenario two is having a greater percentage than design scenario one at 10% to 9%. However, design scenario one is having a shorter period in years than design scenario two at 9 years to 10 years.

9. Conclusion

Design development scenarios one and two are compared in order to evaluate the greater potential plan throughout indicators as shown in Table 8.

Design scenario one had designated only two design programs without application of PUD and having accepted financial outcomes. Design scenario two had developed through the application of PUD with six design programs and having greater satisfactory financial outcomes when compares to the design scenario one. All design programs are feasible except for apartments due to high land prices on high-density land uses and its income (monthly) is insufficient.

Table 7. Phasing Development: Design Development Scenario Two

Phasing Development: Scenario Two		Payback period (years) (average)	Q1	Q2	Q3		Q4	
			Year 0-4	Year 5-9	Year 10-14	Year 15-19	Year 20-24	Year 25-30
Infrastructures (Phase One)	Private Roads	0	●	-	-	-	-	-
	Pedestrian	0	●	-	-	-	-	-
	Park	0	●	-	-	-	-	-
	Utilities	0	●	-	-	-	-	-
Residential (Phase Two)	Apartment	-	-	-	-	-	-	-
Commercial (Phase Three)	Department Stores	11.0	-	-	●	-	-	-
	Offices	11.0	-	-	●	-	-	-
	Hotel	8.6	-	●	-	-	-	-

Source: Researcher, 2019

Table 8 Design Development Scenarios Interpretation

		Design Scenario One	Design Scenario Two
Programs	Apartments	Not Feasible	Not Feasible
	Hotels	Feasible	Feasible
	Department Stores	-	Feasible
	Offices	-	Feasible
	Park	-	Positioned
	Utilities	-	Positioned
Average on All Programs	Net Present Value (NPV)	85,459,190 Baht	98,946,514 Baht
	Internal Rate of Return (IRR)	8%	10%
	Payback Period	9 Years	10 Years

Source: Researcher, 2019

It is cleared that the study area Pahonyothin 19/1 has the potential for applying PUD for the development. Design scenario one was developed under the conventional planning system which does not have the flexibility of modifying land uses density and potential of site planning and design. Whilst design scenario two gives the flexibility to the site planning and design, and be able to modify development density within the project area. However, great financial aid and time consuming will be required more than development without applying PUD.

10. Recommendations

10.1 Carbon Reduction Through Planned Unit Development (PUD):

Carbon reduction has become a global commitment for all countries participated in the COP21 (United Nations Climate Change Conference) in Paris 2015.

Today CO_2 emissions from the residential sector in developing countries are around 143.5 kg of CO_2 /capita, while those of developed countries are around 967.5 kg of CO_2 /capita. However, rapid urbanization in developing countries contributes to the increase in energy supply and consequently results in a rapid increase in CO_2 emission. As urbanization expands along with more household accommodation, more energy is consumed and more carbon emission has been produced by the residential sector (Williams, 2012).

The challenge is that the Thai government had committed itself to reduce this harmful emission of greenhouse gases to 20-25% by the year 2030.

Planned Unit Development (PUD) is a regulation that potentially can encourage urban development projects tackling the reduction of CO_2 emission through planning control and design guidance. A portion of the project area planned as green space provides plantations to absorb toxins and transforms air quality. In spite of this, the PUD is maximizing pedestrian and minimizing automobile mobility. Thus, less carbon emission from the streetcar and more sustainable transportation modes such as walking, cycling, and mass transit system would be proposed along with the PUD density modification measure. As revealed in this study, PUD will positively reduce greenhouse gas emissions. It supports the commitment of the Thai government regarding the outcome of COP21.

10.2 Urban Heat Island (UHI) Mitigation Through Application of the Planned Unit Development (PUD):

The situation of increasing urban temperature has become a serious issue throughout the world. the Urban Heat Island (UHI) are generated in the area with high building density and reflective surface, and in the area with less plantation. Humans produce heat island transformation in urban areas by human activities such as traffic, air-conditioning and, industry. Planned Unit Development (PUD) can mitigate the heat island through three main strategies (under planning control and design guidance): cool roofing, cool paving, and cool surrounding area with trees and vegetation (Gartland, 2008).

10.3 Promoting Transit Oriented Development (TOD) Through Planned Unit Development (PUD):

Planned Unit Development (PUD) generates mixed-use development through various kinds of building uses and providing public spaces and open spaces in a project area. Any mass transit station that meets the PUD requirements can be developed into an area providing public space and mixed-use development following the Transit Oriented Development (TOD) scheme. With the PUD density modification, the project can maximize building density around the station area that would contribute to investment needs, while minimizing car dependence through pedestrianization (Bernick & Cervero, 1996)

10.4 Positioning in SDG 11: Sustainable Cities and Communities by Planned Unit Development (PUD):

The essence of SDG 11 consists of (1) ensuring access for all basic services, safe and affordable housing; (2) integrity and sustainable human settlement planning and management; (3) protecting and safeguarding the world's cultural and natural heritage; (4) infrastructure sustainability; and (5) improving air quality. The intention of SDG 11 goals can be achieved through the city's design following PUD measures such as providing affordable housing, safe street design, infrastructure sufficiency, and carbon reduction (United Nations, 2019).

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