

# Urban Sprawl Effects on Settlement Areas in Urban Fringe of Jakarta Metropolitan Area

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## Abstract

The growth of Jakarta Metropolitan Area, physically marked by rapid growth in urban fringe area, which is forming a settlement areas where its growth tend to be widespread and dispersed randomly as well getting out of control (urban sprawl phenomenon). Urban fringe area is a transitional zone which in the urban pressures process that resulted in the degradation of environmental and institutional fragmentation so its growth process lead to unsustainability. The aims of this study were to identify of urban sprawl effect by analyzing growth of settlement areas and analyzing sustainability status of settlement areas also determining the obstacle element of institutional fragmentation in urban fringe settlement management. Analysis were done by using GIS technique, Multi Dimensional Scalling (MDS) and Interpretative Structural Modelling (ISM). The result showed that the growth trends increasing every year with an acceleration of 2.35 and a sprawl index of 7,21. The sustainability status of settlement area were less sustainable with an sustainability index of 41,46. The main obstacle element were weak coordination among institutions involved in the management to address the rapid growth in settlement areas and absence of zoning regulations as instruments for controlling the growth of the settlement area.

**Keywords:** Jakarta Metropolitan Area, settlement areas, urban fringe, urban sprawl

## 1. Introduction

Urban growth in Indonesia especially in Jakarta Metropolitan Area, physically marked by rapid growth in urban fringe areas (Firman 2003). This situation led to a shift in the function of urbanity to the outskirts that became widespread and dispersed randomly also getting out of control, it was the phenomenon of urban sprawl (Rustiadi 2000). Urban sprawl phenomenon occurs in all the metropolitan cities around the world (Webster 2002). The impact of this phenomenon is very detrimental but most of the country is difficult to control. Based on the results of studies (Daniels 1999, Rustiadi 2003, Winarso and Kombaitan 2001, Firman 2003, Galent 2004) were known that the cause of this growth was emergence of new settlements where to accommodate population growth, development residential, industrial and commercial activities.

The growth of settlements in Jakarta Metropolitan Areas, especially urban fringe area would still continue in the future (Firman 2003) that was because trends metropolitan population growth still high. Urban fringe area in the metropolitan systems was still an attractive area to be a place to live where of land prices are relatively cheap than land prices in the city and location is still within reasonable distances for roundtrip (Winarso and Kombaitan 2001), also urban fringe population activity was experiencing an increase (Soegijoko 2010).

Due to the phenomenon of urban sprawl, caused settlement area in urban fringe growing spill over became inefficiency and wastefulness in land use. This condition can be seen from land-use and land-cover change of built up areas (Ariefin 2012). This situation caused a negative impact on the environment (Soegijoko 2010), so that the process of development of settlement area on urban fringe leading to unsustainability and occurred institutional fragmentation (Hudalah et al 2010). In these conditions it becomes important to question the effect of the phenomenon of urban sprawl on sustainable development process of settlement areas on urban fringe, whether environmental, social, economic and institutional dimensions.

The aims of this study were to identify of urban sprawl effect by analyzing growth of settlement areas and analyzing sustainability status of settlement areas also determining the obstacle element of institutional fragmentation in development urban fringe settlement management.

## 2. Methodology

### 2.1 Research Location

The Study was conducted in the urban fringe on Jakarta Metropolitan Area, by consideration : a) the occurrence of the urban sprawl phenomenon is the most rapidly along the main transport corridor is the area around the tol road Jakarta - Bogor with a distance of 15 km to 30 km from the city center (Zain 2000, JICA 2003, Hidajat 2004), b) urban fringe area that includes several administrative districts/cities that contiguous district are kecamatan Gunung Putri Bogor District, kecamatan Cimanggis and kecamatan Tapos Depok City and kecamatan

Jati Sempurna Bekasi City (Figure 1).

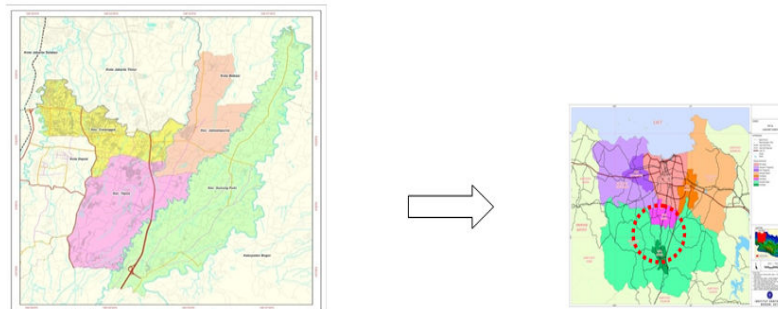


Figure 1. Study Area

## 2.2 Methods

Methods use through analyzes of Landsat TM Imagery coverage of 1982, 1992, 200, 2005 and 2010 which is based on Geographic Information System (GIS) software. Analysis of consistency between land cover settlement (built up area) with spatial planning is done through the process of overlaying the land cover map of settlements in year 2010 under the guidance of spatial plan (RTRW). Analyzes trend growth rate of the settlement area using regression analysis and calculation of index sprawl values periode 2005 – 2010.

$$\text{Index Sprawl} = \frac{\% \text{ growth of built up areas}}{\% \text{ growth of population}}$$

Analyzes the sustainability status using a multi-disciplinary rapid assessment method is Multi Dimensional Scaling (MDS) with software Rap-fish (Fauzy and Anna 2005) were modified to Rap-urbanfringesett. Sustainability status in this study were analyzed with the four dimensions of sustainability namely ecological, social, economic and institutional. Sustainability analysis conducted through three stages :

- 1) Attributes determination for sustainable settlement management criteria, which includes dimensions of environmental, economic, social and institutional.
- 2) The valuation of each attribute in an ordinal scale based on sustainability criteria for each dimension. The scoring is based on the result of questioneres in accordance with the stipulated requirement. The scores ranged from 1 – 4, which is interpreted from strongly disagree (poor) to strongly agree (good).
- 3) Results of the scoring was analyzed using Rap-Urbanfringesett program to determine the position of the sustainability status in each of these dimensions (see Table 1).

Table 1. Sustainability Index and Status

Index	Category
0,00 – 25,00	Poor (not sustainable)
25,01 – 50,00	Less (less sustainable)
50,01 – 75,00	Fair (fairly sustainable)
75,01 – 100,00	Good (Sustainable)

Leverage analysis is used to determine the sensitive attributes which are very influential in improving the status of sustainable development of urban fringe settlement. The determination sensitive attributes is based on the priority of analysis leverage result that taking into account of the changes the root mean square (RMS) ordination on the X axis. The greater the change in RMS value, the greater the role of these attributes in increasing the sustainability status of urban fringe settlement.

Interpretive Structural Modeling (ISM) used to develop several types of structures, including the influence of the structure (for example: support or negligence), the priority structure (for example: more important than or reverse previous study) and categories of ideas (for example: included in the same category as ). ISM analyze the elements of the system and solve them in graphical form direct relationships between elements and levels of hierarchy.

## 3. Result and Discussion

The growth of settlement area (built up area) were approached with land cover change analyzes in study area year 1982, 1992, 2000, 2005 and 2010. The results of analysis are presented in Figure 2. and Table 2.

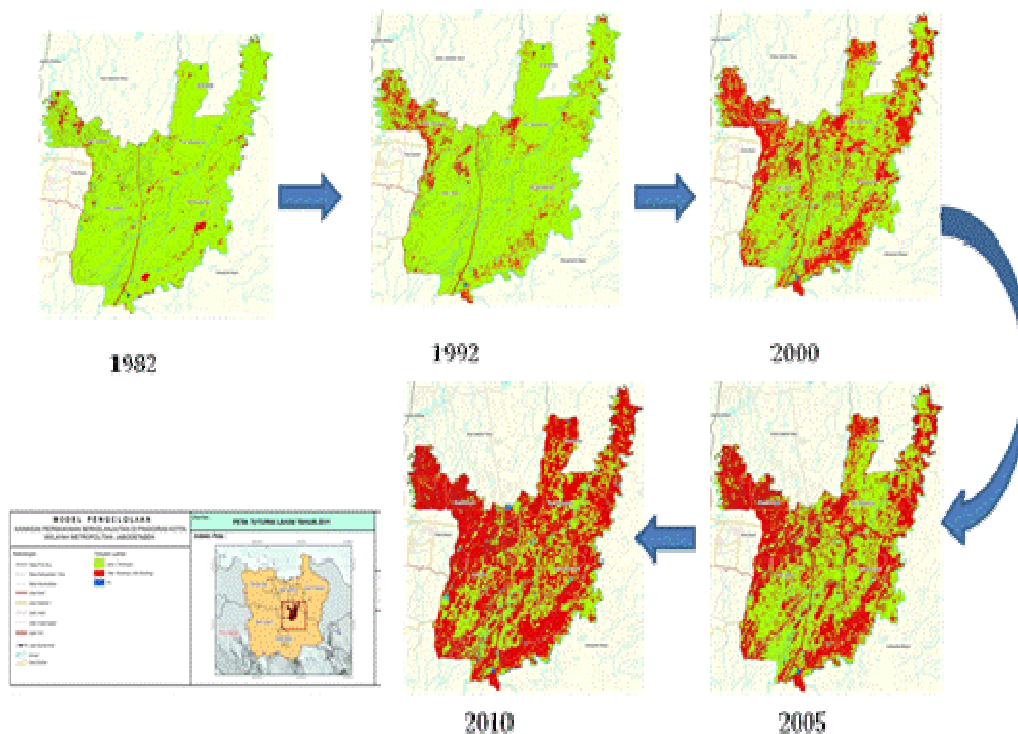


Figure 2. Dynamics of Settlement Area (Land Cover Change of Built up Area) Year 1982-2010  
 Table 2. Percentage of Settlement Area (Built up Area) in Year 1982-2010

Year	Built up area (%)			
	Depok	Gunung Putri	Jati Sampurna	Study Area
1982	3,45	3,57	1,94	3,26
1992	11,99	6,24	6,02	8,49
2000	38,36	35,49	27,06	35,26
2005	53,29	48,49	38,44	48,76
2010	72,21	63,21	68,14	67,59

In years 1982-2000 settlement area (built up area) in study area had been fragmented according to the easy of accessibility. In this decade, the development of lower-middle-class housing is done on a small scale is particularly the case in the kecamatan Cimanggis. Jakarta urban fringe has been became of choice due of the land is still relatively cheap and can take advantage of the infrastructure and existing utilities. Housing development created because there is a relatively near from new city (Depok). The establishment of a new city (Depok) were then led to a lot of new settlement in the small and large scale in urban fringe. Settlement is in small scale and stand alone, although unrelated side causing inefficiencies in the provision of facilities and utilities by government. In this period study area dominated by the construction of residential housing built independently (non real estate).

In the years 2000-2005, built up area in kecamatan Cimanggis and Tapos have joined, fused and formed new growth that spreads irregularly thus become inefficient land use. Further in kecamatan Gunung Putri and Jaka Sampurna, built up area grew along the main road. This condition happens to be larger and rapidly due to be triggered by the rapid development of large and medium-scale housing by the private developers were not integrated. The change agricultural land into built-up areas in the study area very rapidly triggered by land prices are cheap and there is a change and diversification of activities of urban people who live and came to the study area that led to the rapidly development of trading and services activities also industries activities that require land.

In the years 2005-2010, land use in study area were a mixed land use that dominated by conditions and activities urban as a settlement area with high density housing characteristics, commercial, services activities and industry. The growth of settlement development increased because existing access to the city core and planned regional infrastructure development such as highways and arterial roads relatively good. This condition makes the growth of settlements through the administrative boundaries.

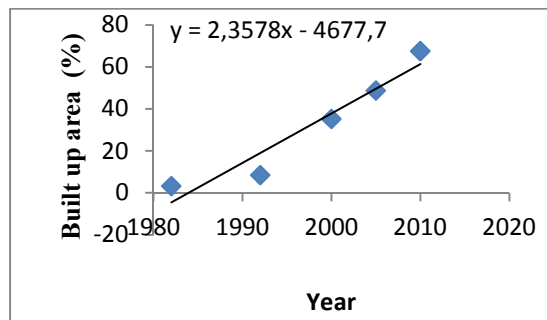


Figure 3. The Trend of Built up Area (Settlement Area) in Study Area

Based on the result of the regression equation (Figure 3.), the trend of growth of settlement area (built up area) in the study area increased each year with an acceleration of 2.35 %. If within a period of 20 years this condition continues, the study area is dominated by the built up area has a negative impact on the environment.

Sprawl index values in year 2005-2010 at the study area was 7.21 means that during year 2005 to 2010 the growth built up area (settlement area) is dominant compared to the population growth. The growth built up area exceeding population growth by changing the green area through the rapid development of new housing on a large scale and was followed by a decrease in the average number of family members per household, as well as an increase in activity due to changes in population and diversification of urban activities such as the development of commercial, facilities, utilities and industry.

Integration between the growth of built up area with spatial planning (RTRW) by overlaid was obtained the proportion of built up area in year 2010 inconsistent by referrals in the spatial planning (RTRW) that was an area has been a deviation because this area should be referred as an non built up area. (see Figure 4.)

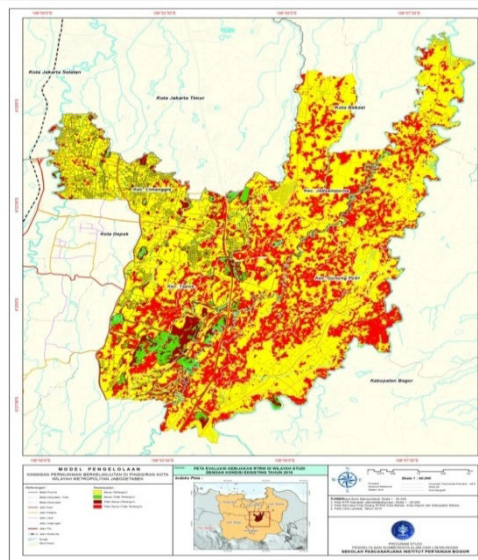


Figure 4. Integration Between Spatial Planning with Settlement (Built up) Area Year 2010

Table 3. Integration between Land Cover with Spatial Planning

Spatial Planning	Land Cover at Study Area Year 2010 (%)		
	Built up area	Non Built up area	Total
<b>RTRW Depok</b>			
Built up area	64,98	19,14	72,23
Non Built up area	20,12	7,65	27,77
Total	72,21	26,79	100
<b>RTRW Kab. Bogor</b>			
Built up area	63,37	35,92	99,29
Non Built up area	0,35	0,36	0,71
Total	63,72	36,28	100
<b>RTRW Kota Bekasi</b>			
Built up area	55,58	11,24	66,82
Non Built up area	12,58	20,6	33,18
Total	68,16	31,84	100

Figure 4. and Table 3. describe that kecamatan Cimanggis and Tapos (Depok) had a high enough proportion inconsistencies area of 20.12%, kecamatan Jati Sampurna has a proportion inconsistencies area of 12.58%, while kecamatan Gunung Putri has a very small proportion inconsistencies area of 0.35%. This indicates that the effects of the phenomenon of urban sprawl causes uncontrolled growth of built up area.

The attribute sustainability status in order to know the status of the sustainability of settlements in the study area as a effect of the urban sprawl phenomenon obtained 37 attributes consisting of 10 attributes ecological dimension, 10 attributes social dimension, 9 attributes economic dimension and 8 attributes institutional dimension .

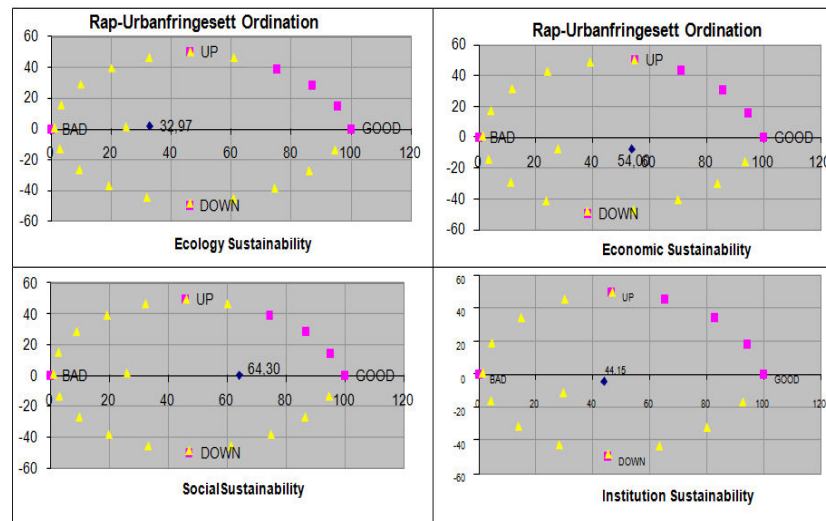


Figure 5. Sustainability Status Index

Figure 5. show that the result of sustainability status analysis for four dimensions in study area. The ecological dimensions is sustainability index value of 32.97. It is the category of less sustainable due to 4 attributes bad score are the growth rate of built up area, drainage condition, solid waste management, the availability of green space, and 6 attributes moderate score are population density in settlements, building density, built up area, environmental sanitation, water supply, accessibility conditions.

Sustainability status of social dimension is sustainability index value of 64.3. It is fairly sustainable category due 4 attributes resulting score a good are of security, service level health facilities, education and social; 4 attribute moderate scores are the social conflict, community participation in waste management, public perception of the environment and the level of community development in the field of environment; 2 attribute bad score are the rate of population growth and the level of education of the population.

Sustainability status of economic dimensions is sustainability index value of 54. It is fairly sustainable category, which caused 3 attributes good scores are availability of public transport, access to activity centers and the economic value of land; 5 attributes moderate scores are the economic value of land, increased revenue, network infrastructure, developed land area, population and trade services the number, and 1 attribute bad score is the number of population in the agricultural sector.

Sustainability status of institutional dimensions is sustainability index value of 44.15. This included the category of less sustainable due to a bad score 3 attributes that cooperation between local governments, the availability of detailed plans, the availability of zoning regulations; 4 attribute moderate scores are the coordination of environmental, coordination of infrastructure, the implementation of sanctions and the availability of licensing mechanisms; 1 attribute good score which has the availability of spatial analysis hukum. Overall result of 41.46 multidimensional index of sustainability including sustainable low category. This is due to the low value of 4 dimensions of sustainability index that assessed

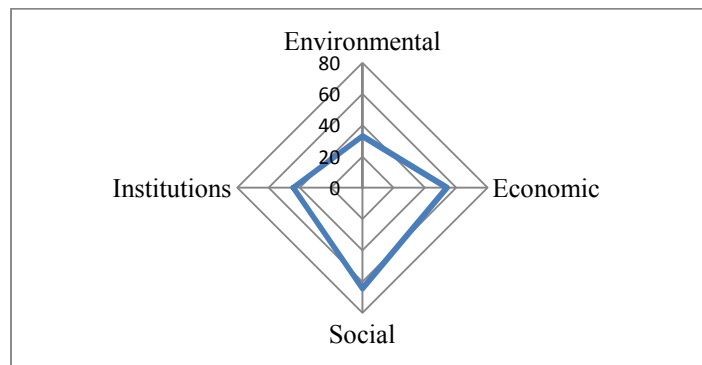


Figure 6. Kite Diagram

Kite diagram (Figure 6) illustrates the comparison of sustainability index values between the environmental, economic, social and institutional dimensions.

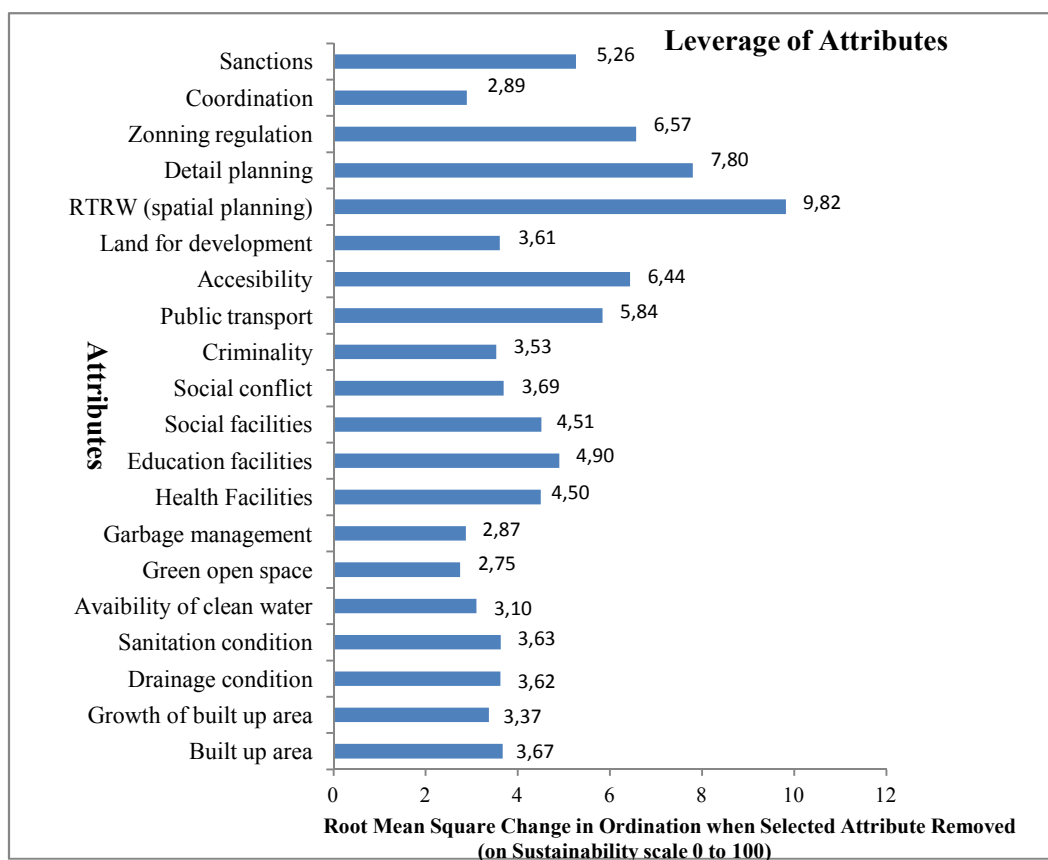


Figure 7. RMS Value of The Multidimensional Attributes

Figure 7 show that the leverage analysis of multidimensional attribute that is a combination of sensitive attributes of the four dimensions of sustainability. These attributes are very influential in improving the status of sustainable development of urban fringe settlement.

Obtained 20 (twenty) attributes as attributes of the levers in improving the status of suatinability of the study areas that need intervention. Four attributes need to be reduced or controlled intensity activities (growth of built up area, built up area, social conflict and criminality), 8 attributes need to be improved intensity activities (drainage, sanitation, water supply, green open space, garbage management, health care facilities, educational facilities and social facilities), 2 attributes must be promptly prepared and made (zoning regulations and a detailed plan of the area) and 6 attributes need to be controlled in the implementation and development activities must be planned carefully (availability of public transportation, accessibility to city centers, spatial planning, coordination, land development and the application of sanctions in violation spatial).

Analysis results of the Interpretive Structural Modeling (ISM) indicate that there are obstacles element to improve institutional fragmentation of urban fringe settlement management. The elements will be elaborated

further towards various sub-elements. Classification sub-element refers to the results of Reachability Matrix (RM) which has fulfilled transitivity rules are classified into four sectors, namely:

- 1) Sector I : weak drive-weak dependent variables (Autonomous). Sub-elements are included in this sector are generally less concerned with the system.
- 2) Sector II : weak drive-strongly dependent variables (Dependent). Generally sub-elements are included in this sector are sub-elements that are not free.
- 3) Sector III : strong driver-strongly dependent variables (Linkage), must be carefully considered because of the relationship between variables that not stable and can have an impact on other variables and feedback effects can magnify the impact.
- 4) Sector IV : strong driver - weak dependent variables (Independent) is a sub-element called free variables.

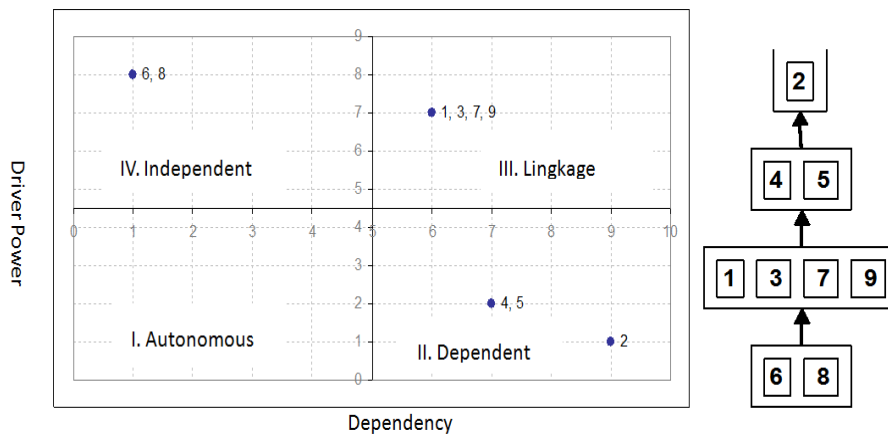


Figure 8. Constrain Elements Classification and Hierarchi Relationship

There are two sub-elements with the highest value of the driving forces that a key element of the obstacles encountered in the management of settlement areas in the study area are coordination among the institutions involved in the development and management of settlement areas are still weak (6) and zoning regulations as a means of control does not exist (8). They are located in sector IV (independent), which has the highest value and the value of driving a low dependency. This means that if coordination in the management of settlements and improved operational technical guidance in the form of zoning regulation is available, then this will be a driver of positive (increasing) the quality of the sub-elements located in sector III (linkage) and sector II (independent). The contextual relationship and hierarchi level of obstacles in the management of urban fringe settlements is presented at Figure 8. The hierarchi structure indicate that obstacles encountered will be solved step by step in accordance with the hierarchy . The development of unplanned settlements (2) is located at the lowest position or level 1. This indicates that the sub-elements is the most influenced and moved by other driving powers from other sub-elements, which are located at the higher levels. If it is considered the driving power and the dependency level, sub-element at level 1 together with the sub-element at level 2, have low driving power and strong influenced by the sub-elements at level 3 and 4. While the sub-element at level 4 is the most influential for improvement of the management urban fringe settlement areas in the study area. This means that by increasing co-ordination that is supported by the availability of detailed plans in the form of technical and operational guidance it will be able to overcome the obstacles that exist at other hierarchy.

## 5. Conclusion and Recommendation

### 5.1 Conclusion

The research demonstrates that urban sprawl has impacted negatively on sustainability development in study area. Rapid growth of settlement area have acceleration and magnitude of 2.36 per year and 7.21 sprawl index made the status of multi-dimensional sustainability in study area is less sustainable. The growth of settlement area in study area is dominant compared to the population growth in study area, this occurs because of the increased activity of the population that is changes and diversification of urban activities such as the development of trade, facilities, utilities and industry. Also The growth exceeding population growth by changing the green area through the rapid development of new housing on a large scale and was followed by a decrease in the average number of family members per household, The high percentage of built-up area that is inconsistent with the spatial planning (Rencana Tata Ruang Wilayah - RTRW) showed uncontrolled development.

The research indicate that there are 20 (twenty) attributes levers need to be intervention in order to improve the

sustainability of the status at the study area and a key element of the obstacles encountered in the management of settlement areas in the study area are coordination among the institutions involved in the development and management of settlement areas are still weak and zoning regulations as a means of control does not exist.

### 5.2 Recommendation

Environmental conditions in the study area are diminishing due to rapid physical growth require immediate implementation of spatial planning in an integrated, holistic and integrated administration by encouraging inter-regional cooperation mechanisms among local governments in study area.

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