Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.6, No.12, 2014

Determination Sustainability Status in Urban Infrastructure and Policy Recommendation for Development Case Study: Bandarlampung City, Indonesia

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Abstract
There are many aspects and actors involved in city infrastructure development require a comprehensive and integrated policy towards sustainabilty. Therefore it is important to identify the measuring instrument determine the ability to build a sustainable infrastructure. In order to determine the key indicators of this study, stakeholder assessment, public opinion and assessment of existing infrastructure planning documents were included. The aims of this paper were to identify key indicator for sustainable infrastructure development policy by analizing indicators in sustainable infrastructure development and analizing sustainability status of city infrastructure. The results of review on previous studies and discussions with experts set 5 dimensions and 47 attributes of sustainable infrastructure development. By using Rapid Appraisal of Infrastructure (Rapinfra) analysis indicated that the sustainability status of Bandarlampung infrastructure was less sustainable with a value of 38.05 %. Meanwhile, Analytic Network Process (ANP) analysis of the composite indicator produced 8 key indicators of the most influential in the development of sustainable infrastructure, they consisted of: air quality, growth of built up area, community participation, citizen behavior, local economic growth, water availability, infrastructure planning and infrastructure budgets.
Keywords: ANP, key indicators, Rapinfra, sustainability infrastructure, city

Introduction

High population growth in city areas has implications for the improvement of the community infrastructure needs. Marvin and Slater (1997) stated that the relationship between cities and infrastructure is now emerging as a key city policy issue. Many relevant aspects and actors involved in city infrastructure development and planning and it required a comprehensive and integrated policy to be sustainable (Sing and Steinberg 1996, Marvin and Slater 1997, Pandit *et al*. 2011, Morrisey *et al.* 2012). A variety of strategies, policies, plans and programs of action for the development of an integrated and sustainable infrastructure in urban have been prepared, but the development of urban infrastructure still faces unresolved issues (Miharja 2007). Infrastructure development does not only affect the economic aspects, but also social and environmental aspects, those are the main dimensions of sustainable development. Therefore, it is important to determine the measuring instrument to identify the ability to build sustainable infrastructure.

Previous studies on sustainable infrastructure reflected the need to design and manage engineering systems by the environment, social and economics consideration. The study include: municipal water system sustainability criteria (Sahely *et al*. 2005; Danko and Lourenco, 2007), sustainable transportation (Barter, P and Raad, T 2000; Sahely *et al*. 2005; Litman and Burwell 2006; Tamin, 2007; Haghshenas and Vaziri 2012; Kusbimanto 2013), drinking water system (Sahely *et al*. 2005; Danko and Lourenco, 2007; Saniti, 2012) waste water systems (Sahely *et al.* 2005; Danko and Lourenco 2007; Setiawati *et al.* 2013), rainwater systems (Suripin, 2004; Andayani, 2012; Benzerra 2012), green infrastructure (Aji, 2000; Mell, 2009; Putri 2013) and solid waste (Astuti, 2011; Safitri 2012). Based on these studies it is known that there has been no research on criteria and indicators for integrated and sustainable infrastructure. Therefore, the main objective of this paper is to develop a sustainable infrastructure development policy, with specific objectives, such as, firstly: to define criteria and indicators of sustainable infrastructure development of the city, secondly: to measure the level of sustainability of the city's infrastructure, and thirdly: to formulate the indicators that influence the city sustainable infrastructure development. The influential indicators was obtained from the results of stakeholders assessment, public opinion and the assessment of infratsructure planning report against all indicators of sustainable infrastructure development. This research was conducted in Bandarlampung which is one of the fast-growing large cities in Indonesia and in year 2015 it is expected becoming a metropolitan city (Pontoh and Kustiwan 2009).

The Research Methods

The scope of the city infrastructure research restricted to a basic network infrastructure that influence city development, namely: transportation, water systems (drinking water, storm water, waste water), green open spaces and solid waste. The research was carried out by Multi Dimensional Scaling (MDS) method, which consisted of the application of Rapinfra (Rapid Appraisal of Infrastructure) and Analytic Network Process (ANP). The primary data were the data obtained directly from respondents through Focus Group Discussion (FGD) and the data collected from questionaire survey of the community in Bandarlampung City. FGDs conducted in Bandar 3 times (July 2013, August 2013, and January 2014). The sampling technique in this research was the method expert survey (Marimin 2002) by conducting in-depth interviews to the 15 respondents who had been determined. For the survey to the public, the sampling technique the purposive sampling was used to 126 respondents. Analyzing the sustainability status using Multi Dimensional Scaling (MDS) with software Rap-fish (Fauzy and Anna 2005) were modified to Rapinfra. Sustainability status in this study were analyzed with the five dimensions of sustainability namely environmental, social, economic, technology and good governance. Sustainability analysis conducted through three stages: 1) Attributes determination for sustainable infrastructure development, which includes dimensions of environmental, economic, social, technology and good governance. 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 questionaires in accordance with the stipulated requirement. The scores ranged from 0 – 3, which is interpreted from strongly disagree (poor) to strongly agree (good). 3) Results of the scoring was analyzed using Rapinfra program to determine the position of the sustainability status in each of these dimensions (Table 1).

Leverage analysis was used to determine the sensitive attributes which was very influential in improving the status of sustainable infrastructure development. The determination of sensitive attributes was 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 city infrastructre.

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)

Analytic Network Process (ANP) was used to determine the influential indicators of sustainable infrastructure development. The steps of selecting influential indicators as follows: 1). Determination of criteria and indicators based on expert consultation from the results of the previous analysis was based on a literature study, stakeholders and public opinion 2). Determination of the relationship between indicators was obtained through questionnaires 3). Construction of an alternative network model was based on the results of step 1 and 2. 4). Scaling interest for alternative indicators of sustainable infrastructure development. 5). Testing consistency of pairwise comparison matrices that already meet the inconsistency ratio ≤ 10%. The next step is to calculate the weights of criteria and synthesis of indicators alternative of sustainable infrastructure development with a super decisions software use.

Results and Discussion

The findings on sustainable criteria and indicator for infrastructure development from various studies were summarized in Table 2. Analyzing for indicators of sustainable infrastructure development on previous research, there were obtained 5 criteria with 50 indicators for sustainable infrastructure development (Table 3).

Table 2. Sustainability citeria and incators for different infrastructure system from various studies (2000-2013)

Citeria and indicators	Transportation					Drinking Water			Storm water (Drainage)				Waste water			Solid waste			Green open space		
Environmental criteria:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Air pollution (ambient air quality)	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-
2. Emission levels (motor vehicle), GHG	X	-	X	-	X	X	-	-	X	-	-	-	X	-	-	-	-	X	-	-	-
3. Noise pollution (noise level Traffic)	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
4. Area of green space and network	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
5. Conversion rate of land (land use)	X	X	-	X	X	X	-	-	X	X	-	-	X	-	-	-	-	X	-	X	-
6. Controlling land use	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. Landscape condition	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
8. Use of energy (fuel consumption)	X	X	X	X	X	X	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-
9. Use of renewable energy	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10. Land degradation	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. The efficiency of movement / mobility	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
12. Environmental management (3 R) /quality	-	-	-	X	-	-	X	-	-	-	-	-	-	X	X	X	-	X	-	-	-
13. The environmental impact of facilities	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14. Protection of wildlife / habitat / biodiversity	-	X	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	X
15. Water pollution/water quality	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	-	-	-	X	-	-
16. The efficiency of natural resources	-	X	-	-	-	-	X	-	-	-	X	-	-	X	X	-	-	X	-	-	-
17. Material and construction waste	-	-	X	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-
18. Pollution of ground water (ground)/quality	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	-	-
19. Permanent puddle and flood	-	-	-	-	-	X	-	-	X	-	X	-	X	-	-	-	-	-	-	-	-
20. Environment Aesthetic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
21. Ecological network (hubs-nodes-corridors)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
22. Water resources (air baku)	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Economic criteria:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. The regional Economic Growth	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Gross Regional Domestic Product	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Budget implementation infrastructure (OM)	X	X	-	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	-	-	-
4. The Local Government Revenue	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
5. Trip fee/service fee	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Growth centers	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. The growth of land value	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
8. Dimensions of city area	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9. Infrastructure rate/user fee	X	X	X	X	-	X	-	X	X	-	-	-	X	-	-	-	-	-	-	-	-
10. Revenue per capita	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. Supporting industrial/ investment develop.	X	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Creation of jobs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
13. Absorption of labor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-
14. Revenue population	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
15. Local Economic Development (LED)	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	X	X	-	X
16. Saving of roads maintenance	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Social criteria:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Population growth	-	-	-	-	X	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-	-
2. Levels traffic(infrastructure) accidents	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. The Safety level	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
4. The Security level	-	X	X	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	X	-
5. Behaviour of community as an infras. user	-	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
6. The healthy level	X	X	X	-	X	X	X	-	X	-	-	X	X	X	-	X	-	-	X	-	X
7. Growth of private vehicles	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Education and skills rate	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	X	-	-	X	-	X
9. Welfare society level	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
10. Population density	-	X	-	-	X	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-
11. Facilities for the disabled	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12. Access to public services	X	-	X	X	X	X	-	-	X	-	-	X	X	-	-	-	-	-	-	-	X
13. Satisfaction of road (infrastructure) users	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14. Levels Traffic violations	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15. Equity / fairness	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16. Survival rate	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-
17. Making infiltration wells by community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Protection of culture resources/traditional	-	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
19. The social interaction and social access	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X
20. Willing to pay	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Technology Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Capacity of infrastructure (supply)	X	-	-	-	X	X	-	-	X	-	-	-	X	-	-	-	-	-	-	X	-
2. Levels of service (performance)	X	X	X	-	X	X	-	X	X	-	-	-	X	-	-	-	-	-	X	-	-
3. Integration of infrastructure	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Development of road network	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Diversification of transportation mode	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Bike and pedestrian path	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. Facilities for pedestrian (crossing bridge)	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Facilities non-motorcycle vehicle	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9. Infrastructure technology (design of infra.)	-	-	-	-	-	-	-	X	-	X	-	-	-	-	-	X	-	X	-	-	-
10. The public transport quality	-	-	X	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
11. Easily obtained/operated of technology	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-
12. Diversification of green open space	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
13. Leakage	-	-	-	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-
Governance criteria:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Law enforcement and sanctions/control	X	-	-	-	X	X	-	-	X	-	-	-	X	-	X	-	-	-	-	-	-
2. Quality of human resources	-	-	X	-	X	-	-	X	-	-	-	X	-	-	-	-	X	-	-	-	-
3. Community participation	X	X	X	X	-	X	-	X	X	X	X	-	X	-	-	-	X	-	-	X	-
4. Planning	-	X	X	-	-	-	-	-	-	X	-	X	-	-	-	-	-	-	-	-	X
5. Budget development and R & D	X	X	X	-	X	X	-	-	X	X	-	-	X	-	-	-	-	-	-	X	-
6. Regulation / Law	X	-	-	-	-	X	-	X	X	-	X	-	X	-	-	X	X	-	-	X	-
7. Institutional	-	-	-	-	-	-	-	X	-	X	X	-	-	-	-	-	X	-	-	X	-
8. Call Center	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-
9. Cooperation (between regions, private-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-
goverm)	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X
10. Integrated infrastructure institution	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	-
11. Conformity with the Spatial planning																					

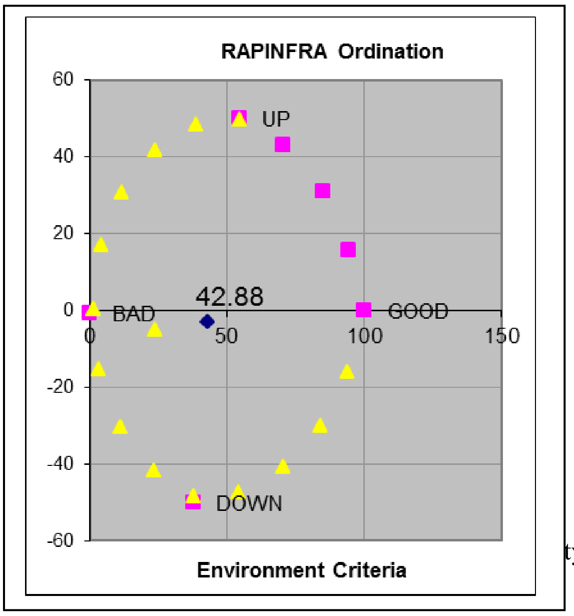
Note: 1, 6, 9, 13 Sahely, *et al.* (2005), 2. Litman and Burwell (2006), 3. Tamin (2007); Barter, P and Raad, T. (2000), 4. Haghenas dan Vaziri (2012), 5. Kusbimanto (2013), 7., 14 Danko and Laurenco (2008), 8. Saniti (2012), 10. Andayani (2012), 11. Suripin (2004), 12 Benzerra *et al.* (2012), 15. Setiawati *et al.* (2012), 16. Astuti, dkk (2011), 17. Safitri (2012), 18. Chalik et al, 2011, 19. Putri (2013) 20. Aji (2000), 21. Mell (2009).

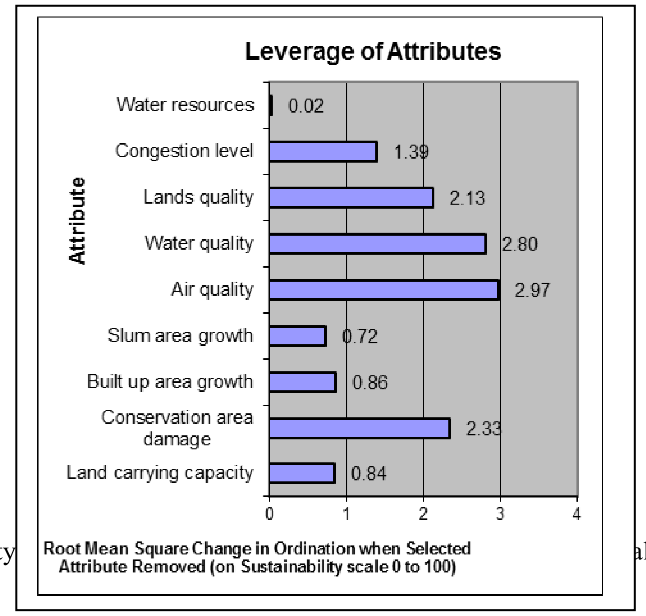
Table 3. Criteria and indicators of sustainable infrastructure

Environmental Criteria	Social Criteria	Economic Criteria	Technology Criteria	Good Governance Criteria
1. Land carrying capacity 2. Conservation area damage growth 3. Built up area growth 4. Slum area growth 5. Air quality 6. Water quality 7. Land quality 8. Availability of water resources 9. Traffic congestion level 10. City landscape	1. Population growth 2. Number of poor 3. Human Development Index (HDI) 4. The community sewage system 5. Catchment areas by public 6. Processing trash by community 7. Artesian/shallow wells by community 8. Levels of security &safety 9. Unemployment rate 10. Levels of traffic accident 11. Community behaviour (culture)	1. Economic growth 2. City Revenue growth 3. Investment growth 4. The city budget growth 5. Level of per capita income 6. Minimum city wage 7. Levels of local economic growth 8. Infrastructure services fee 9. Land value	1. Drainage systems 2. Sewage system 3. Drinking water system 4. Solid waste management 5. Green Open Space systems 6. Road systems 7. Bicycle lanes / non-motorcycle vehicle 8. Facilities for pedestrians 9. Public transportation	1. Regulation 2. Planning (sectoral) 3. Inter- sector institution 4. The visionary leadership 5. Spatial planning 6. Law enforcement 7. Socio-political conditions 8. Call center 9. Budgeting 10. Human resource capacity in goverment 11. Community participation

The criteria and indicators which resulted from literature review in Table 1 were used for further consulted with experts through focus group discussions (FGD). From the FGD, it fixed the number of criteria to be 5 criteria, while the number of indicators was reduced to 47 indicators.

The results of MDS using Rapinfra showed that the sustainability index value of environmental criteria was 42.88% as shown in Figure 1. It was classified as less sustainable, due to 2 attributes laid in bad score which were the rate of conservation, damage and level of traffic congestion. Seven (7) attributes laid in moderate score which were land carrying capacity, the growth rate of built up area, slum area growth, air quality, water quality, land quality and water resources. The less sustainable status was influenced by 4 key indicators that leverage analysis results and it can be seen in figures root mean square (RMS). Key indicators were indicators of the middle to the highest RMS value. The RMS of key indicators were air quality level; the rate of conservation area damage; the level of water quality; the soil quality level (Figure 2).





The sustainability index value for social criteria was 15.80 % and classified as not sustainable. The category was not sustainable due to 7 attributes laid in bad score which were the population growth, the number of poor, artesian/shallow weel by public, catchment area by public, trash processing by public, community behaviour, and safety, security, comfort level. It was also due to 3 attributes laid in moderate score which were HDI, sewage system by public and unemployment rate (Figure 3). The unsustainable status was affected by the 6 key indicators. The RMS of key indicators were: the rate of human development index; the sewage system by public; unemployment rate; trash processing by public; catchment area by public and the making artesian or wells drilled by the public (Figure 4).

The sustainability index value for the economic criteria was 43.88 % which was relatively less sustainable. The category was less sustainable due to all economic attributes laid in moderate score (Figure 5). The less sustainable status was influenced by three key indicators, that the RMS of key indicators were: the rate of investment; level of income per capita, and the local economy growth (Figure 6).

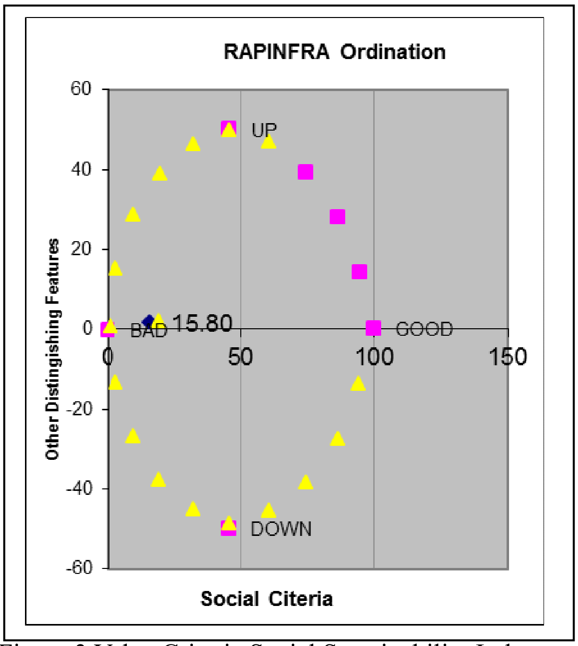


Figure 3 Value Criteria Social Sustainability Index

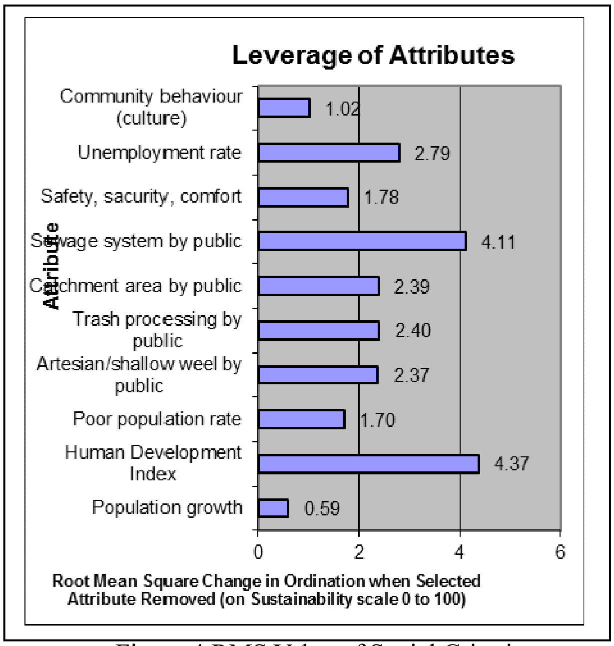


Figure 4 RMS Value of Social Criteria

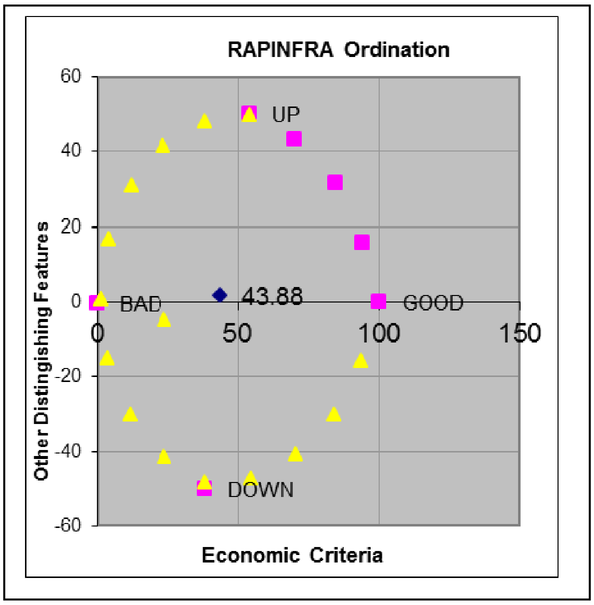


Figure 5 Value Criteria Economic Sustainability Index

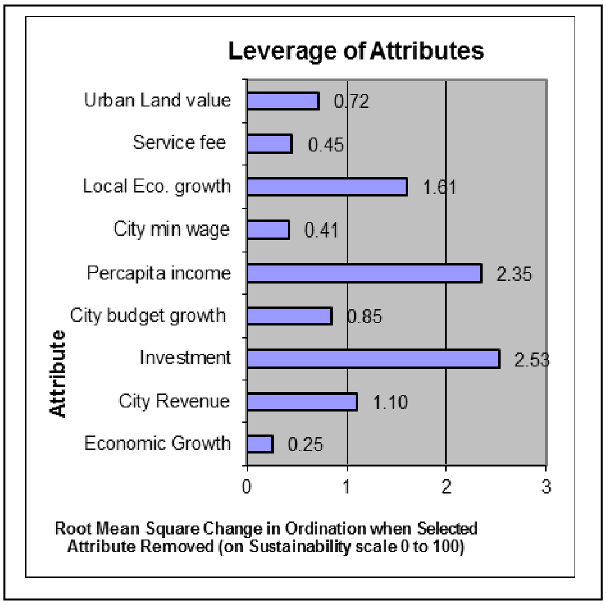


Figure 6 RMS Value of Economic Criteria

Sustainability index value for technology criteria was 28.32 %. It was classified as less sustainable due to 5 attributes laid in bad score which were sewage system, drinking water system, bicycle lanes/non-motorcycle vehicle, facilities for pedestrians, public transportation. Four (4) attributes laid in moderat score which were drainage systems, solid waste management, green open space systems and road systems (Figure 7). The less sustainable status was influenced by eight key indicators, the RMS of key indicators were: the level of water services; availability of green open space; availability of roads; availability of pedestrian facilities; waste management; availability of municipal sewage system; the availability of bike lanes/non- motorcycle vehicles and the availability of public transport systems (Figure 8).

The sustainability index value of good governance criteria was 44.58 %. It was classified as less sustainable due to 4 attributes laid in bad score which were regulation, inter-sector institution, law enforcement, social political conditions. Five (5) attributes laid in moderate score which were the visionary leadership, spatial planning, budgeting, human resource capacity in goverment, and community participation. Only one attribute laid in good score, it was call center (Figure 9). The less sustainable status was influenced by 5 key indicators, the RMS of key indicators were: law enforcement; call centers; inter-sector institution; leadership, and the local socio-political conditions (Figure 10).

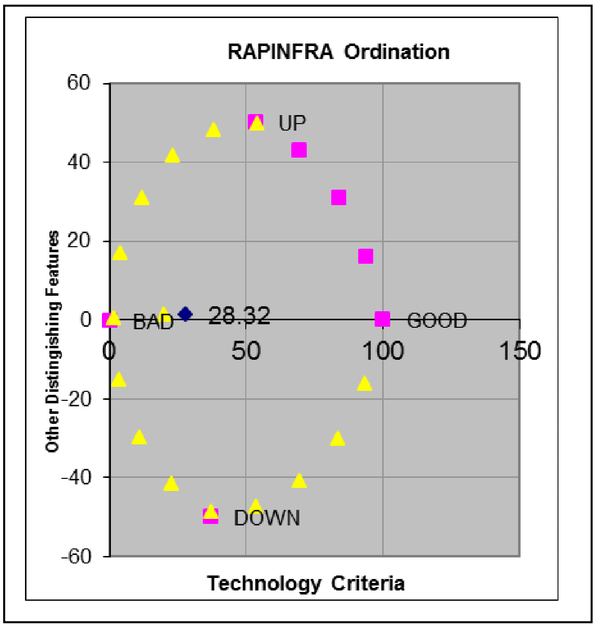


Figure 7 Value Criteria Technology Sustainability Index

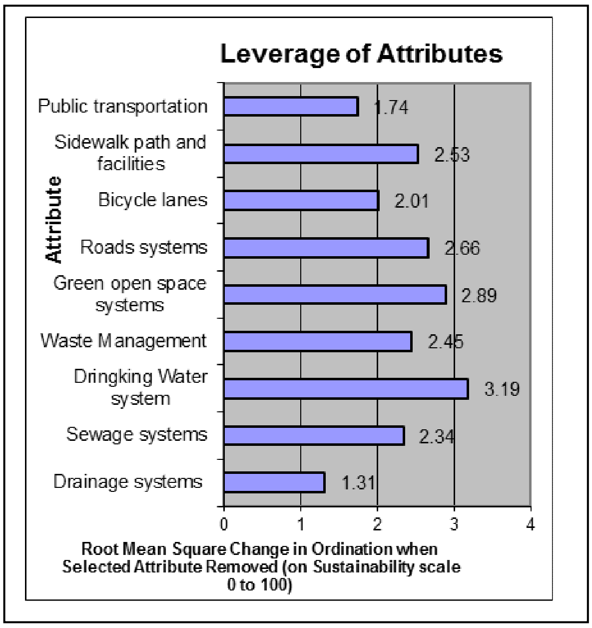


Figure 8 RMS Value of Technology Criteria

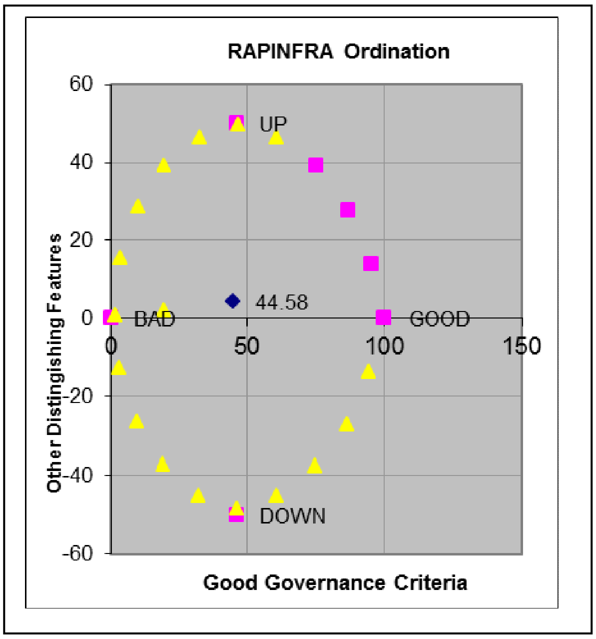


Figure 9 Value Criteria Good Governance Sustainability Index

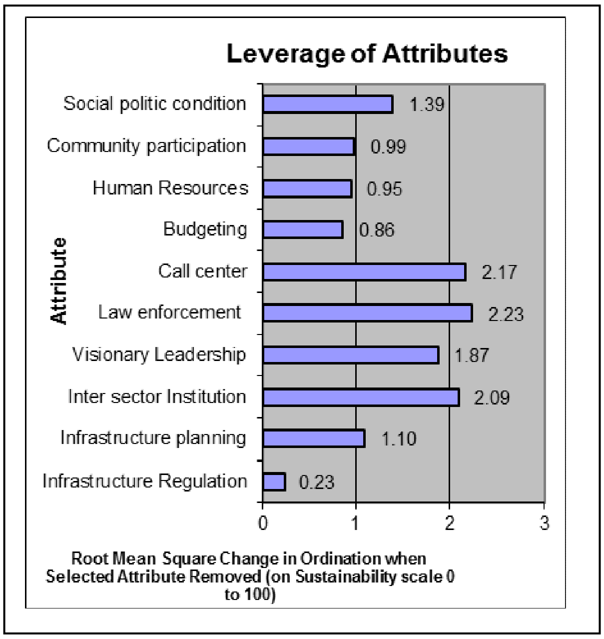


Figure 10 RMS Value of Good Governance Criteria

The results of MDS using Rapinfra shows that multicriteria sustainability infrastructure Bandarlampung index value was 38.05 % or less sustainable , as shown in Table 4 and Figure 3.

Table 4 Status of Bandarlampung infrastructure sustainability

No.	Criteria	Index Value	Sustainability Status
1	Environment	42.88	Less sustainable
2	Economic	43.88	Less sustainable
3	Social	15.80	Not sustainable
4	Technology	28.32	Less sustainable
5	Governance	44.58	Less sustainable
		38.05	Less sustainable

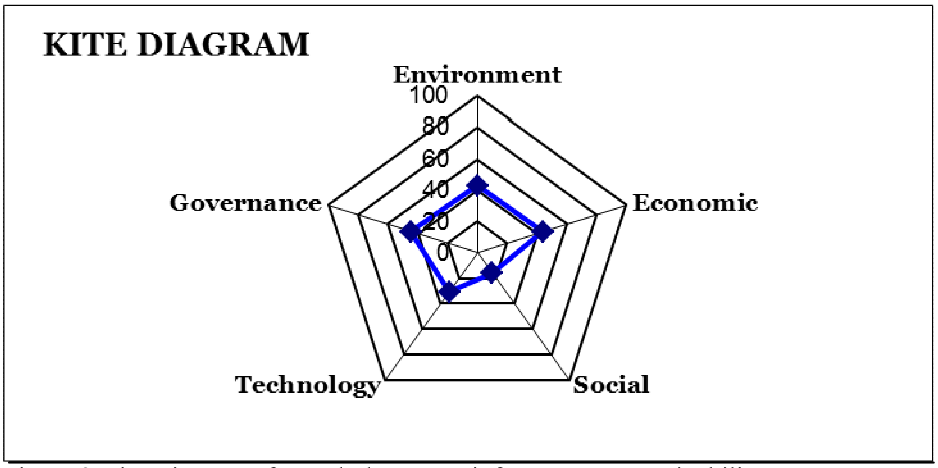


Figure 3 Kite Diagram of Bandarlampung infrastructure sustainability status

To determine whether the indicators examined in MDS analysis was quite accurate and can be justified scientifically, this can be seen from the stress and the coefficient of determination (R2). This value was obtained in the MDS analysis using Rapinfra software. The results of the analysis were considered sufficiently accurate and reliable because it has a smaller stress value of 0.25 or 25% and the coefficient of determination (R2) values approaching 1.0 or 100 percent (Kavanagh and Pitcher 2004). The analysis showed that all indicators were assessed fairly accurate and accountable. It was shown that the stress value by 14% -15% and the coefficient of determination (R2) of 0.95% (Table 5). Stress value indicates the proportion of variance that was not explained by the model. It showed that, the lower the value the better the model MDS stress.

Table 5 Values of stress and the coefficient of determination (R2)

Parameters	Sustainble Criteria					
	Environment	Social	Economic	Technology	Governance	Multi-criteria
Stress	0.15	0.14	0.15	0.14	0.14	0.14
R2	0.95	0.95	0.95	0.95	0.95	0.95
Iteration	2.00	2.00	2.00	2.00	2.00	3.00

Indicators are influential in the community

The community survey showed that 24 indicators of the level of importance according to 5 criteria. Influential indicators for environmental criteria were 5 namely : the level of congestion, water quality, availability of raw water sources, air quality and growth of built up area. There were 5 influential indicators for social criteria, namely: HDI level, level of security and safety, unemployment growth rate, waste management system by community and community behavior. There were 4 influential indicators economic criteria, which include: city minimum wage level, local economy development, the growth of infrastructure budget and economic growth (GDP). Influential indicators for technology criteria were 6 consist of: the availability of drinking water system, waste management system, drainage system, green open space system, wastewater system, and public transport system. There were four influential indicators for governance criteria, namely: visionary leadership, law enforcement, infrastructure planning and infrastructure budget.

Influential indicators in planning documents

The sustainable infrastructure planning was one important factor towards sustainable city infrastructure development. It was part of the infrastructure development process that takes into account the balance between sustainable development criteria, namely: economic, social and environmental as well as based on the technology and good governance. Planning document, which it was the reference of infrastructure development was the Spatial Plan, Sectoral Master Plan and Mid-Term Development Plan (RPJMD). There was also the Mid-Term Infrastructure Plan (RPIJM) space -based and sector and it was currently in the process of preparing the plan.

The results showed that the existing infrastructure development plans in the form of a program of activities still does not meet the indicators of sustainable infrastructure development even most plans do not formulate some sort of performance indicators as a measure of development, except RPJMD.

Indicators of sustainable infrastructure development on RPJMD were 28 indicators consist of: 6 indicators of environmental criteria, namely: reduced rate of destruction of mountains and hills (conservation area), city slum area, growth of built up area, reduced air pollution, preservation water sources and reduced traffic congestion point. The attributes of social criteria were include 5 indicators, namely: increasing HDI level, reduced the number of poor, security and safety; waste management and unemployment rate. Economic criteria which consist of 5 indicators were: economic growth, city revenue growth, GDP growth rate, the rate of minimum city wage. Criteria technology has 7 indicators namely: growth of number of roads, arranged green open space areas, reduced sedimentation of waterways and drainage, increasing water service, available sewerage installation, available facilities and mass transit traffic. Good governance criteria has 5 indicators, namely: increasing the amount of the approved legislation, capacity building through discipline and education of civil servants, availability of media complaints, budgeting, availability of information planning in accordance with the implementation plan.

Influence indicators that results of ANP

The key indicators of MDS previous results (26 indicators) then combined with the results of the community survey (24 indicators) and outcome indicators in the assessment of infrastructure planning documents (28 indicators) to obtain the most influential indicators in the sustainable infrastructure development. Composite indicator made up of indicators that appear at least twice in all three stages of the analysis, in order to obtain 27 indicators (Figure 4).

Figure 4 shown that there were 27 the powerfull indicators in sustainable infrastructure development. The environmental criteria has 6 indicators namely: availability of raw water, air quality, water quality, damage of conservation, growth of built up area development and traffic congestion. The social criteria has 4 indicators consist of: HDI, security and safety, unemployment rate, public participation and citizen behavior. The economic criteria has 4 indicators namely: the rate of investment, income per capita, the rate of the local economy and minimum city wage. The technological criteria has 7 indicators namely: the availability of clean water systems, waste management, green open spaces, road network, drainage system, waste water system, and public transport. The governance criteria has 6 indicators including: visionary leadership, call center, law enforcement and sanctions, infrastructure planning and infrastructure budgets.

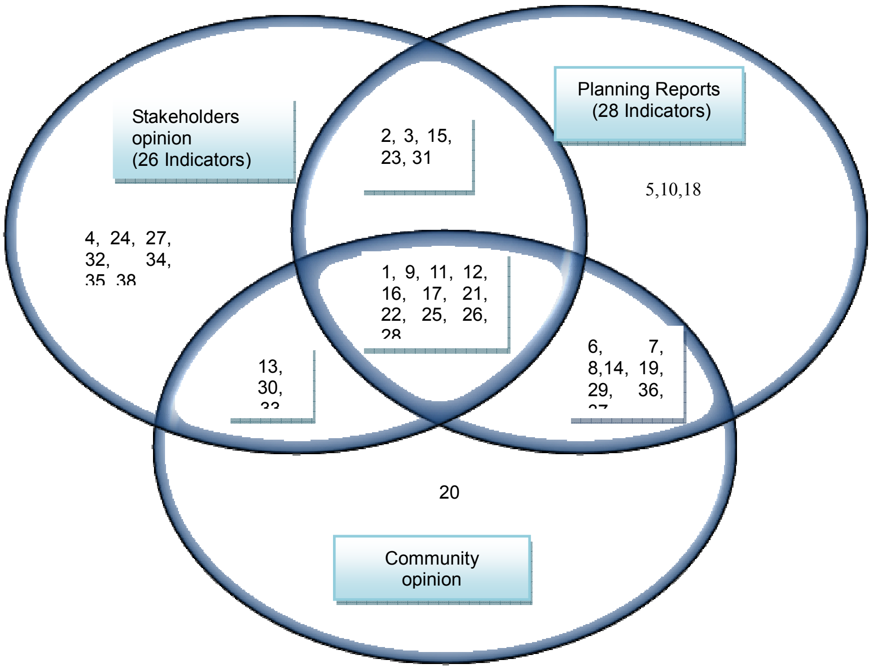


Figure 4: Diagram Ven of Powerfull Indicator in Sustainable Infrastructure Development

1. Air quality
2 . Water quality
3 .Damages of conservation area
4 . Soil quality
5 . Slum area
6. Built up area
7 . Availability of raw water supply
8 . Traffic congestion
9 . HDI (Human Development Index)
10 . The number of poor people
11 . Participation of Community
12 . Unemployment rate
13 . Community Behavior
14 . The security and safety
15 . The rate of investment
16 . Revenue per capita
17 . Llocal economic growth
18 . The rate of city revenue
19 . Minimum City Wage
20 . City budget
21 . Availability Clean Water
22 . Availability of green open space
23 . Availability of road
24 . Availability of sidewalk
25 . Availability of solid waste manag.
26 . Availability sewage system
27 . Availability of bicycle lanes
28 . Availability public transport
29 . Availability of drainage system
30 . Law enforcement
31 . The call center
32 . Institutions across sectors

The 27 powerfull indicators on Figure 4 discussed by experts in the FGD and obtained 20 indicators, and then these indicators will be processed at the stage of ANP (Figure 5 and Figure 6).

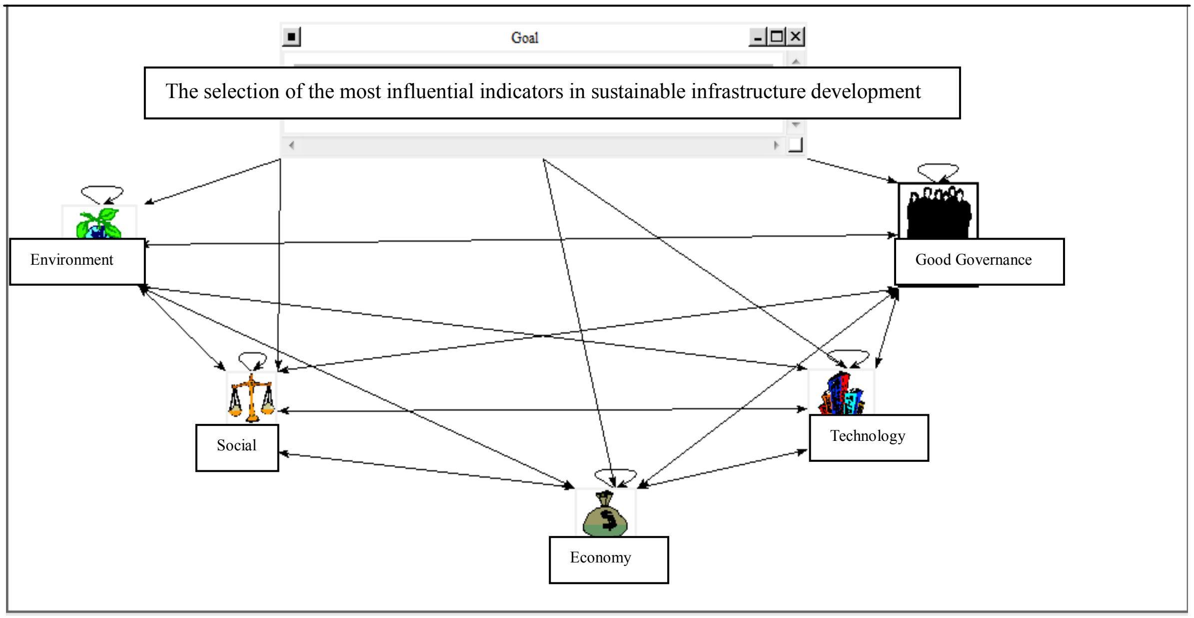


Figure 5 The Network of ANP Sustainable Infrastructure Development Model

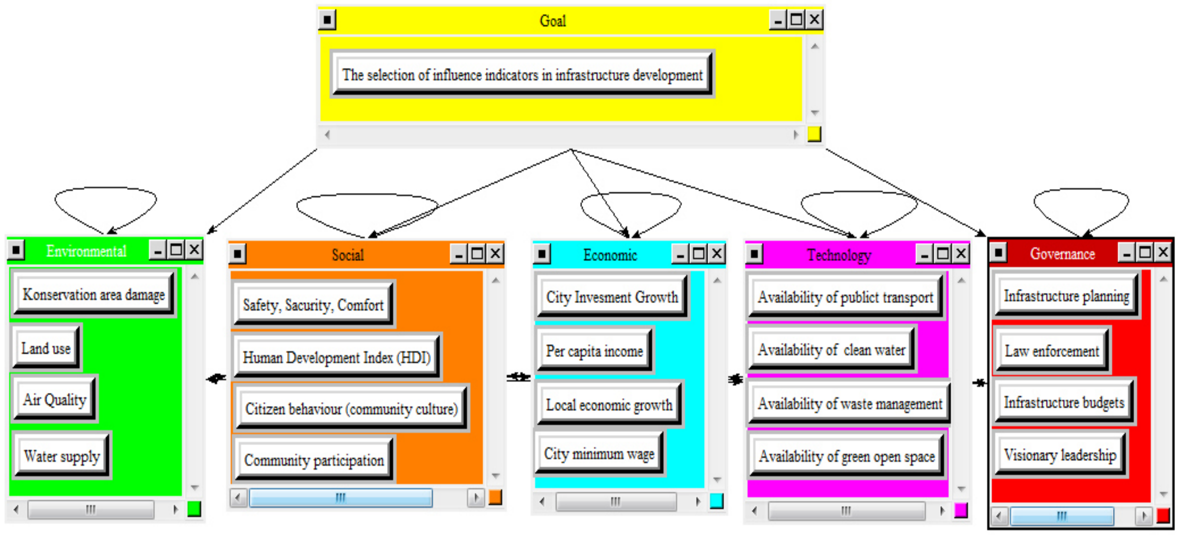


Figure 6 Structure of ANP Sustainable Infrastructure Development Model

The calculation result with the super decisions obtained the weight of each indicator, the greater the weight of indicator, the greater the influence of these indicator on sustainable infrastructure development. There were 8 main indicators that the most influential of sustainable infrastructure development (Table 5). The most influential indicator on economic criteria was local economic growth with weights 0.725. For governance criteria, there were two indicators that have a major influence, namely: infrastructure planning with weights 0.475 and infrastructure budget with weights 0.446 . On the technological criteria, the most influential indicator was the availability of clean water system with weights 0.425. For social criteria there were two indicators that used to great effect, namely: community participation with weights 0.418 and people's behavior with weights 0.404. On environmental criteria, there were two major indicators that influence namely: air quality with a weight of 0.369, and the growth of built up area with weight 0.345 (Table 6).

Table 6 Results of ANP assessment for the overall priority indicator

Kluster	**Indikator**	**Rangking**	**Bobot**
Environment Criteria	1. Air quality	1	0.368606
	2. Built up area	2	0.344698
	3. Water resources	3	0.148823
	4. Conservation area damage	4	0.137873
Social Citeria	1. Community participation	1	0.417962
	2. Community behaviour	2	0.404128
	3. Security and safety	3	0.099182
	4. Human development Index (HDI)	4	0.078728
Economic Criteria	1. Local economic growth	1	0.724725
	2. City investment growth	2	0.216621
	3. City minimum wage	3	0.030612
	4. Per capita income	4	0.028042
Technology Criteria	1. Availabitliy of dringking water systems	1	0.425344
	2. Availability of public transportation	2	0.236539
	3. Availability of solid waste management	3	0.200489
	4. Availability of green open space system	4	0.137628
Good Governance Criteria	1. Infrastructure planning	1	0.474703
	2. Infrastructure budgeting	2	0.445862
	3. Law enforcement	3	0.079435
	4. Visionary leadership	4	0.000000

The results of the analysis of ANP recommend policy directions in the development of sustainable infrastructure ought to consider 8 key indicators namely: local economic growth, infrastructure planning, infrastructure budgets, availability of drinking water systems, community participation, community behavior (culture), air quality and growth of built up area. Policy recommendation in sustainable infrastructure development was the first: the local economic growth that address the needs of micro economic infrastructure such as: provision of space for small enterprise and street vendors in the city. Second: an integrated infrastructure planning between spatial and sectoral development plans. The Indonesian government is currently preparing a program planning development of spatial-based infrastructure to support integrated development through The Medium Term of Infrastructure Investment Program Plan (RPI2JM). This program may be the first step in planning an integrated infrastructure development and sector-based spatial development. This plan can work well if the planning process also involves decision-makers from related sectors. Third: an increase in the infrastructure budget, efficiency and effectiveness of the budget. Fourth: the availability of clean water system which was distributed to all parts of the city, increasing the amount of raw water sources and water management with 5 R (restore, reduce, reuse, recycle, rechargable). Fifth: increased community participation in the management of city infrastructure, building consensus between the government and the residents of the city as well as the transparency of information. Sixth: city infrastructure management that considers the behavior of (cultural) communities, for example the pattern of movement of people in the use of transport (public transport, bicycle or on foot) and open space utilization patterns. Seventh: air quality with the increased use of public transport, periodic emissions testing, vehicle age restrictions, environmentally friendly fuel, green industry and waste management without burning. Eighth: the city land use in accordance with the city spatial plan, that requires the provision of 30% open space, minimizing damage to protected areas (mountains, slopes and hills) and the efficient use of space with vertical building development.

Conclusion

1. The sustainable infrastructure development benchmarks were generated in this study which included some consideration of criteria such as environmental, social, economic, technological and governance, and 47 indicators of sustainable development pillars
2. The status of Bandarlampung infrastructure sustainability was considered as less sustainable with a score of 38.05 % which means that the availability of the infrastructure was still in good condition. However, it needs to be improved to achieve sustainable infrastructure development.
3. The ANP analysis recommended that the policy directions in the development of sustainable infrastructure ought to consider 8 key indicators as follows: the local economic growth, infrastructure planning, infrastructure budgets, availability of clean water systems, community participation, people's behavioral, air quality and growth of built up area.
4. The were eight (8) policy recommendations in sustainable infrastructure development. Firstly: the local economic growth that address the needs of micro economic infrastructure such as: provision of space for small enterprise and street vendors in the city. Secondly: an integrated infrastructure planning between spatial and sectoral development plans should consider the indicators of sustainable infrastructure development through The Medium Term of Infrastructure Investment Program Plan (RPI2JM). Thirdly: an increase in the infrastructure budget for more efficiency and effectiveness. Fourthly: the availability of clean water system which was widely distributed throughout the city by increasing the amount of raw water sources and water management with 5 R (restore, reduce, reuse, recycle, rechargable). Fifthly: increased community participation in the management of city infrastructure, building consensus between the government and the residents of the city as well as the transparency of information. Sixthly: city infrastructure management that considers the community behavior, for example the pattern of movement of people in the use of transport (public transport, bicycle or on foot) and open space utilization patterns. Seventhly: air quality with the increased use of public transport, periodical emission testing, vehicle age restrictions, environmental friendly fuel, green industry and waste management without burning. Eighthly: the city land use in accordance with the city's spatial plan, that requires the provision of 30% open space, minimizing damage to protected areas (mountains, slopes and hills) and the efficient use of space with vertical building development.

Recommendation

In order to improve further sustainability infrastructure development of Bandarlampung, the influential indicators in determining the policy of the city's infrastructure development should be taken into consideration by the local authorities. These indicators for other cities in Indonesia could not be the same since every cities have their own characteristics and problems. Therefore it was necessary to make some comparative study with other cities within the Republic of Indonesia.

Acknowledgement

The author would like to thank to the colleagues of Bandarlampung Climate Change Team for supporting data. Thanks should also be conveyed to the Education Ministry of the Republic of Indonesia for supporting funds for this research through BPPS scholarship.

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