Cost Planning Model of Urban Infrastructure for Sustainable Cities (Research on Martapura City, Banjar Regency, Kalimantan Selatan Province)

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OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at http://www.ssrn.com/link/OIDA-Intl-Journal-Sustainable-Dev.html

Abstract: The purpose of this research are (1) identify and analyze the factors that affect the cost planning of urban infrastructure in the conceptual phase, considering economic, social and ecological aspects; (2) analyze and construct optimum cost planning model of urban infrastructure towards sustainable cities; and (3) analyze the sustainability of cities through the management of infrastructure, considering economic, social and environment aspects. The methodology in this research is quantitative descriptive method. The model was built by the method of analysis with Operations Research (Linier Programming), Analysis Sensitivity, and Dual Price analysis. Unit cost analysis method adapted to the necessary variables, such as the City Hierarchy analysis, Streeter-Phelps Equation, the Cost of Illness Approach, and Benefit Cost Analysis. The data collected was secondary data and primary data. The results showed (1) the factors that influence the cost of urban infrastructure development are economic infrastructure, social infrastructure and environmental infrastructure, particularly the role of BOD-DO in the rivers. (2) The cost planning model of urban infrastructure for river-based city more efficient 10.79% then conventional model. (3) When urban development budget has been optimized, and considere aspects of sustainability, it is possible other activities budgeted for the reduction of urban environmental pollution and improve public health and income of the community, as a model application of the environmental, social, and economic aspects towards sustainable cities. Theoretical implication of this research is "to achieve sustainable cities, improvement of the city finance capability is an absolute effort, by optimizing the city budget based on the cost planning of urban infrastructure is integrated in urban planning, and consider environmental, social, and economic aspects”. The results showed that the analysis of the availability of adequate urban infrastructure affects the increase of regional economic development. Therefore, the cost planning model of urban infrastructure obtained can be used for the management of urban infrastructure policy, towards sustainable cities. The cost planning model of urban infrastructure are constructed consider the environment aspect through the management of river pollution on the river-based city. In addition, the concept of urban planning based on this study using a comprehensive approach that integrates cost planning, development planning, and spatial planning toward sustainable cities.

Keywords: cost planning, urban infrastructures, river, sustainable cities

Introduction

Population or activity in one area there is a concentrated and there are also places where the population is less concentrated and activities. The location where the population or activity is concentrated is called the City (Isard, 1975). Urban development will lead to urban sprawl and other issues such as physical problems, infrastructure, social, cultural, economic, and institutional, if not controlled properly. Such conditions, strategic and anticipatory urban planning demands are able to direct and accommodate the expanding activities of the city. The main problems which led to the emergence of urban problems is fairly rapid development with an increasing number of people, it is not followed by urban infrastructure sufficient to meet the needs of the community. This is because the government unprepared to provide adequate services to the community, the physical condition of the city of inferior quality and evolved without plan (Khudori, 2002).

Martapura is the city with the characteristics of the geographical settlement as river-based city. The problems are quite complex in the region is the presence Martapura River which divides the city. Society depends on the Martapura River because it serves as a means of transportation, irrigation, drainage, ecological and water resources for settlements. The main problem is the poor sanitation in the urban region, because Martapura River used as household waste disposal sites. Based on the results of the water quality of the river by the Environment Agency of South Kalimantan Province BOD at the highest point on the River Martapura monitor is 18.54 ppm, COD 40.33 ppm, and DO 4.125 ppm, which means it is not feasible consumption (Badan Lingkungan Hidup Provinsi Kalimantan Selatan, 2009). Even the World Bank (2007) through the Water and Sanitation Program - East Asia and Pacific Region (WSP-EAP) said the impact of poor sanitation in Indonesia causing economic losses. Accordingly, precise engineering required for the management of river pollution through urban development.

Urban development through the provision of urban infrastructure, which is construction sector, requires budget. However, the city budget is limited (Ritonga, 2010). In consequence, it is necessary to optimization of budgeting, through the the preparation of cost planning of urban infrastructure for the estimated cost in construction in the early stages of conceptual planning. Many previous studies that perform cost optimization of urban infrastructure development that is partially, stating that when the environmental aspects to be considered in the infrastructure development, cost efficiency occurs for the infrastructure management. (Rajguru et al, 2015; Jamaludin et al, 2014; Gaba, 2013; Toyin et al, 2012; Moutinto et al, 2010; Fylakis, 2007; Zhou et al, 2005; Fu et al, 2005; Nicolaou et al, 2001; Fagoyinbo et al, 2001; Eskew et al, 1990; Falk et al, 1975; Usman et al, 1986; and Kan et al, 1974.). According Suparmoko and Ratnaningsih (2012), by maintaining a good environment inevitably cost of construction will be efficient. But the research related to cost optimization of holistic urban infrastructure has not been conducted, so that urban development can benefit as much as possible for the benefit of the city, towards sustainable cities are characterized according to the potential of the city.
It is also important as a means of controlling the budget of urban development through urban infrastructure development.

The purpose of this research are (1) identify and analyze the factors that affect the cost planning of urban infrastructure in the conceptual phase, considering economic, social and ecological aspects; (2) analyze and construct optimum cost planning model of urban infrastructure towards sustainable cities; and (3) analyze the sustainability of cities through the management of infrastructure, considering economic, social and environment aspects.

Literature Review

Urban Area

Urban is defined as the built area with structures and roads, as a settlement centered on an area, where there is a concentration of concentration of people with various types of economic activity, social, cultural, and government administration with a certain density that requires a complete infrastructure, seen from morphological characteristics (Branch, 1995; Zahnd, 1999; Isard, 1975; Sjafrizal, 2012; Adisasmita, 2005a, Tarigan, 2005a, 2005b; and Richardson, 1978).

For the determination of areas as urban areas need to understand some of the location theories. According Nugroho and Dahuri (2012), the location of various activities such as household, shopping malls, factories, farms, mines, schools, and worship place are not random, but rather shows the pattern and arrangement (mechanism). One of the location theories is Central Place Theory proposed by Christaller (1966), analyzed the relationship between size, number and geographical distribution of the activity centers. Identity of activity center indicated the availability of service activities and trade (Adisasmita, 2005b). Relating to its function as a market that provide goods and services to the needs of the population, each activity center will have two conditions relating to the size and extent of the market, that is the threshold services and range area shown in Figure 2.1.

Associated with the position and the relationship between activity centers, both conditions/concepts mentioned above are factors that determine the hierarchical order or orders of the activity centers in a particular region. Christaller proposed market area in the hexagons form of as the most efficient model. In addition to the terms of the hexagons form is also very efficient when associated with the distance factor or cost of transportation (Figure 2.2.).

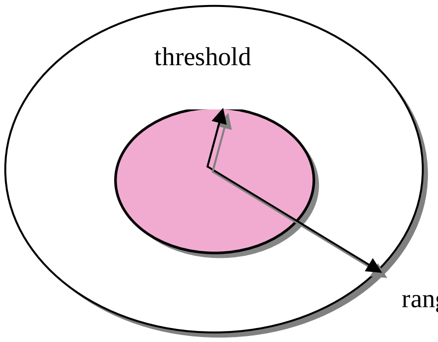


Figure 2.1. Threshold Services and Range Area of Central Place Model
Source; Setiono (2011)

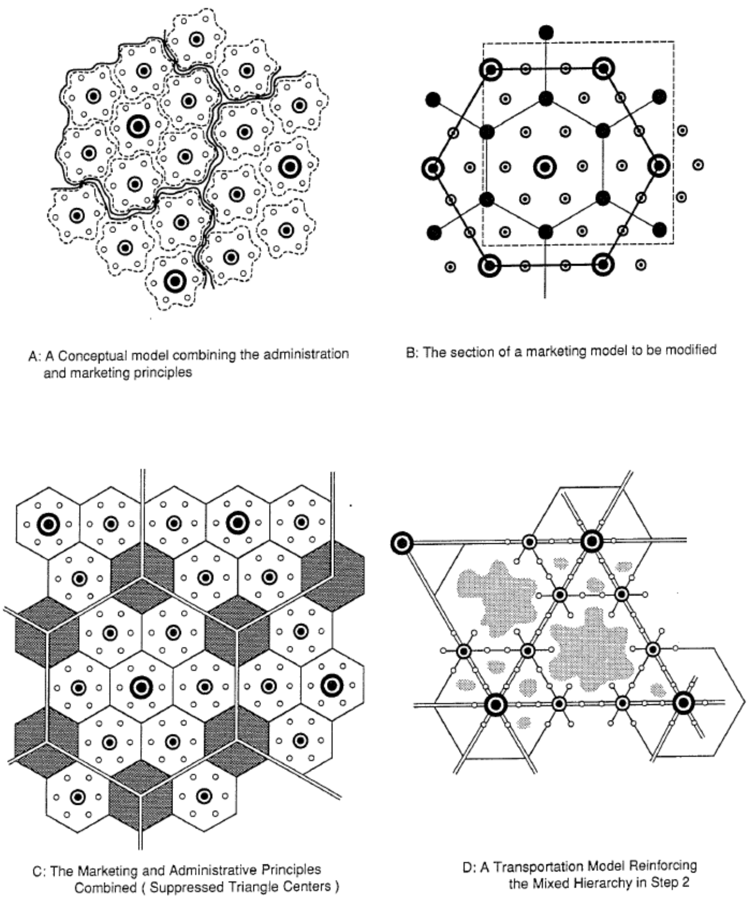


Figure: 2.2. The Formation Process of the Hexagon Model Christaller System
Source: Christaller (1966)

For the purpose of efficient service, Christaller propose another model that uses an approach based on the principle of transport, in Figure 2.3.

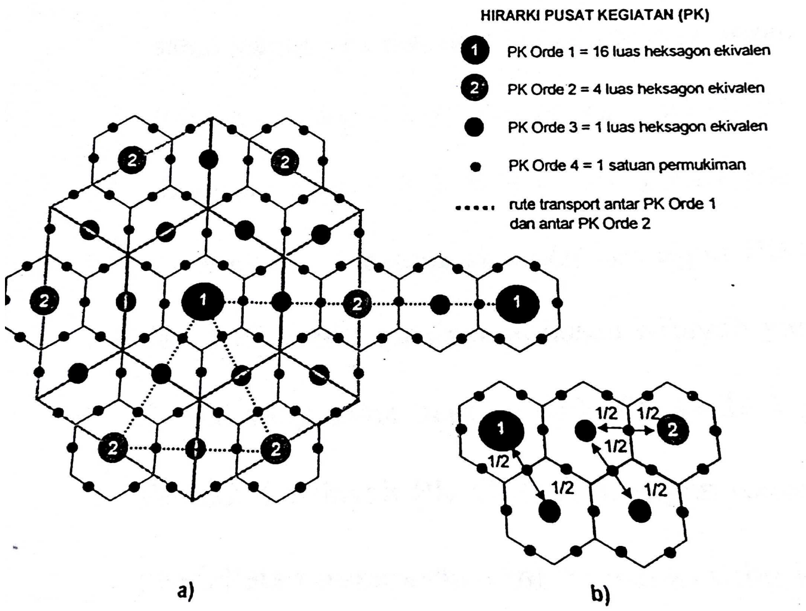


Figure: 2.3. Activity Centers Structure And Activity Center Hierarchy K = 4
Source: Christaller (1966)

Infrastructure

The definition of infrastructure in this study refers to the system and physical that provides transportation, water, buildings, and other public facilities are required to fulfillment of basic human needs economically and socially, or in other words the infrastructure and facilities in the public interest and social (Hudson et al, 1997; Grigg, 1988; and Tarin, 2005a and 2005b).

Cost Planning

In this research is meant Cost planning is cost estimated at the conceptual stage of planning, nd at this stage there is no design, but only in the form of ideas. This phase can also be referred to as an feasibility estimate and conceptual. Nevertheless, the estimated costs are already available for the purposes of decision analysis. Estimated cost at this stage t calculated globally (Ervianto, 2002; Conyers and Hill, 1984; Arsyad, 1999; Hariyono 2010; and Tarin, 2005b; Ahuja, 1994; Suharto, 1997; Asiyanto, 2003; Harrison, 1987 ; Hendrickson and Au, 1989; Soeharto, 1997; and Vazirani, 2001).

City Finance

City Finance aspect is an important part in the city development to serve the needs of urban facilities, which can be implemented private sector and the government sector. To improve the urban development of effective and efficient, increase the city finances capacity is an absolute effort by local municipalities, namely by optimizing the urban facilities development budget (Sjafrizal, 2012; and Suparmoko, 2011)

Sustainable Cities

Sustainable Cities concept includes several main objectives, namely to minimize the use of nonrenewable resources, the achievement of sustainable use of renewable resources and waste absorption capacity of local and global. Measures to achieve these objectives provides connectivity between the natural and built environment or between green and brown agendas. Provision of infrastructure such as transportation system, water, sewerage, electricity, and telecommunications have a key role in city efficiency improvement. Other urban facilities such as schools, health services, social services, market facilities, open space pblic, worship and recreation are also important to the liveable city development (Kusumawanto and Astuti, 2014; Pugh, 2000; and Cruz et al 2007). In the process of regional and development planning, economic aspects has an important role to allocate resources effectively and efficiently in the perspective of short-term and long-term (Rustiadi, Saefulhakim, and Panuju, 2011).

Conceptual Framework

Based on the literature and the paradigm of sustainable cities, required proper management of municipal infrastructure towards sustainable cities. Efforts management of urban infrastructure through cost planning of infrastructure development towards sustainable cities is influenced by many variables. The conceptual framework will describe the relationship between the variables used in this study, which consists of a variable urban areas, urban hierarchy, unit price, urban infrastructure, economic benefits, social benefits and environmental benefits. The conceptual framework of the relationship between variables to construct models of the cost planning model of urban infrastructure towards sustainable cities is shown in Figure 2.8.

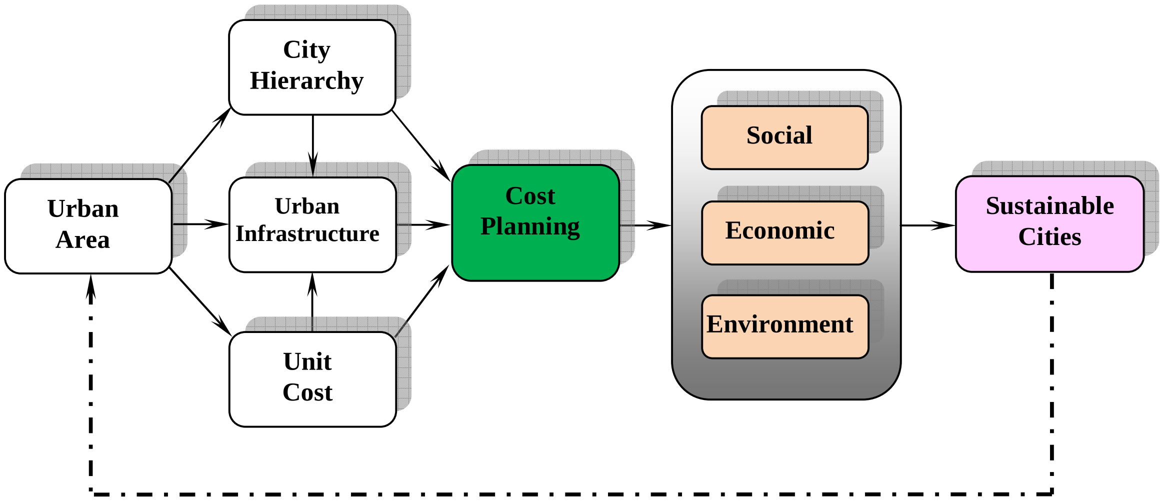


Figure: 2.8. Conceptual Framework
Source: Writer (2015)

Methodology

The methodology in this research is quantitative descriptive method. Based whereas the aim of this research can be grouped into development research and application. Because the study was conducted by applying statistical analysis methods to the development of cost planning model, then implemented. Model building using Operations Research analisys with Linier Programming, Analysis Sensitivity, and Dual Price analysis. Unit cost analysis method adapted to the necessary variables, such as the City Hierarchy analysis, Streeter-Phelps Equation, the Cost of Illness Approach, and Benefit Cost Analysis. The data collected was secondary data and primary data. Data collection method in this research, consist: (1) Literature Review (2) Interview and Observation (3) Secondary Data Collection

Operation Research and Linier Programming

Linier Programming is part of Operations Research, either analysis tools for efficient decision making, through a mathematical model used to solve optimization problems, namely to maximize or minimize the objective function is dependent on a number of input variables. Linear Programasi two kinds of functions: (1) The objective function, direct analysis to detect the purpose of the problem formulation (2) Functions constraints, determine available resources and the demand for those resources.

Linear Program requirements: (1) relationship between variables is linier and constraints must be linear. (2) The model must have an objective function. (3) The model must have a structure constraints. (4) The model must have a constraint that is not negative.

Common form Linear Programming models are as follows:

$$Z = c_1X_1 + c_2X_2 + \dots + c_nX_n \qquad (4.1)$$

where Z, X, and C are the objective function, the constraint Function; and unit cost variabel
Constraints are as follows:
(cona$_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \dots a_{ij}X_j + .. a_{1n}X_n$ ($\geq = \leq$) b_1
$a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + \dots a_{2j}X_j + \dots a_{2n}X_n$ ($\geq = \leq$) b_2
. . . . . .
. . . . . .
$a_mX_1 + am_2X_2 + a_{m3}X_3 + \dots a_{mj}X_j + \dots$ amnXn (> = <) bn
where j = 1, 2, 3 … n
semua kendala tidak sama dengan nol. Variabel operasionalnya adalah *unit cost* t_{ij}.
i = 1, 2, 3, . . . 27 and j = 1, 2, 3, ... 27
Kendala (RHS = Right Hand Side) adalah b_j, j = 1, 2, 3, . . . n
While a_{ij} = coefficient of technology

Sensitivity Analysis
The sensitivity analysis performed to determine the influence or changes to the optimal solution, if there is a change to the data used in these calculations. Through the sensitivity analysis can be known the range of optimality an objective function of problem solving model. If the sensitivity level of the budget increase of more than 10%, then the model is very sensitive.

Dual Prices Analysis
Dual Prices Analysis for determining shadow price of variables or production factors wich is social opportunity cost, in other words the highest value of a variable or production factors as the best alternative. Throughout the changes in resource availability are within range, the value of shadow price/dual prices will remain.

Unit Price Analysis of River Purification (BOD and DO) using Streeter-Phelps Equation

Analyzing unit price of river pollution management by the BOD and DO through Streeter-Phelps Equation approach and Oxygen Sag Curve. Oxygen deficit curve (Oxygen Sag) from node to node can be illustrated in Figure 3.1.

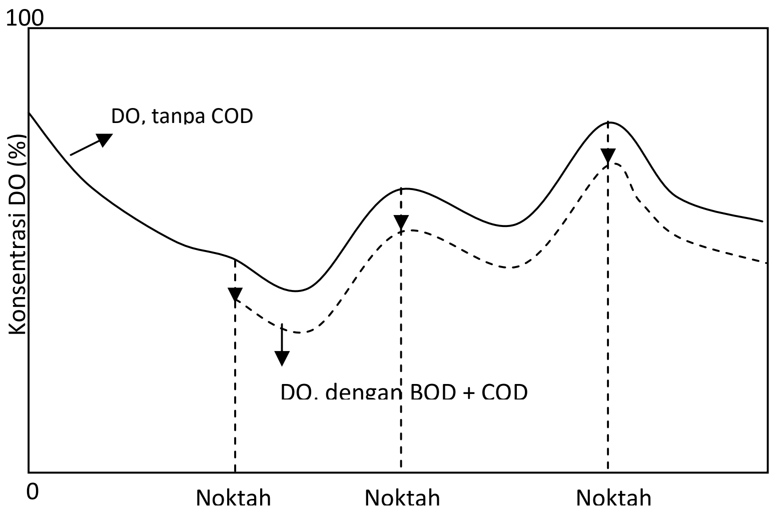


Figure 3.1. Oxygen Deficit Curve
Source: Clark et al (1977)

If the form of differential equations Streeter-Phelps approach is applied, it will produce a linear system of differential equations degree one. In the state of "steady state" (that is, the speed of water flow, temperature, water flow, the average sector in the segment is considered permanent) transfer function obtained by solving the equation and is associated with changes in the concentration of dissolved oxygen (DO) in the segment i due to input BOD in the segment j, is a set of linear relationship.

If XBOD is a vector BOD from pollution sources (kg/day), while ABOD is a matrix coefficient that resulted deficit DO, and D is a vector of deficit DO on node in the river, then the relationship BOD-DO can be written in the form of a matrix as follows:

$$A_{BOD} \cdot X_{BOD} = D \qquad (*)$$

If the decision maker wants to set a standard for a segment, then CS – ABOD . XBOD – NPSDO ≥ S. The left side mean DO concentration in the right segment S is the standard that must be required. Matrix form (*) will be one of the constraint of water quality management in the river basin. NPSDO is the DO concentration which is beyond the predictions of the model, (non-point-source). Transfer coefficient aij is defined as the change (reduction/increase) of dissolved oxygen (DO) in the segment i as a result of the addition/subtraction of a unit BOD of pollution sources in the segment j.

$$a_{ij} = \frac{\Delta \text{DO (i)}}{\Delta \text{BOD (j)}} \qquad i = 1, 2, \dots m; j; = 1, 2 \dots n.$$

If A is the transfer coefficient matrix, then AX is change vector of DO associated with X.

$$AX = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} \qquad (**)$$

Hence flows from upstream to downstream, the pollution sources in the upstream segment can only affect the DO in the downstream segment, not vice versa. This means transfer coefficients a_{ij} only affects for i>j; while for i≤j the value of $a_{ij} = 0$. In this system, transfer coefficient matrix becomes.

$$A = \begin{bmatrix} 0 & 0 & 0 \\ a_{21} & 0 & 0 \\ a_{31} & a_{32} & 0 \end{bmatrix} \qquad (***)$$

On the Martapura River there are 3 segments with 3 dots (including the dot in the estuary) so m = 3; i = 1, 2, 3 out of all the community activities with septic tank. Calculation a21, a31, a32, by considering of water velocity m/sec, water flow m3/sec, and temperature T^o

Combination Affect of BOD and COD to DO

Where,

DO_k	=	concentration of dissolved oxygen in dot (k); (mg/l)
Dot (node)	=	the point where all the BOD, COD measured is assumed to enter and where the standard will be charged
BOD_k	=	point source BOD measured in (k); (kg / day)
COD_k	=	point sources of COD measured in (k); (kg / day)
L_k	=	concentration of BOD (BOD unsatisfied) in (k) before entering BODK; (mg/l)
$\hat{L}_k$	=	Concentration of BOD (BOD unsatisfied) in (k) after BODK entry; (mg/l)
R_k	=	water discharge in (k); (m^3/det)
$C_s(k)$	=	concentration of oxygen saturation in (k); (mg/l)
D_k	=	DO deficit in (k); (mg/l)
$\hat{D}_k$	=	DO deficit in (k), after the rapid reaction COD; (mg/l)
d_k	=	distance between the node (k-l) and node k; (km)
V_k	=	average speed of water flow the (kl) and (k); (m/det)
K_1^k	=	average level of de oksigenesi between node (k-1) and (k); (1/day)
K_2^k	=	average rate of reoxygenation between node (k-1) and (k); (1/day)

α = conversion factor (dk/Vk) into the day and also in conversion factor of BOD/R into mg/l. The calculations show α = 1/86,4

Basic Equations:

$$L_k = \hat{L}_{k-1} \cdot e^{-K_1^k \alpha \left(\frac{d_k}{V_k}\right)} \qquad (3.1)$$

Example $$e^{-K_1^k \alpha \left(\frac{d_k}{V_k}\right)} = \lambda_k$$

$$L_k = \lambda_k \hat{L}_{k-1}$$

$$\hat{L}_k = L_k + \alpha \frac{BOD_k}{R_k} \text{ ;and } D_k = \left(\frac{K_1^k}{K_2^k - K_1^k}\right)\left[e^{-K_1^k \alpha \left(\frac{d_k}{V_k}\right)} - e^{-K_2^k \alpha \left(\frac{d_k}{V_k}\right)}\right]\hat{L}_{k-1} + e^{-K_2^k \alpha \left(\frac{d_k}{V_k}\right)} \hat{D}_{k-1}$$

Example

$$\left(\frac{K_1^k}{K_2^k - K_1^k}\right)\left[e^{-K_1^k \alpha \left(\frac{d_k}{V_k}\right)} - e^{-K_2^k \alpha \left(\frac{d_k}{V_k}\right)}\right] = \delta_1^k \text{ and } e^{-K_2^k \alpha \left(\frac{d_k}{V_k}\right)} = \delta_2^k$$

$$D_k = \delta_1^k \hat{L}_{k-1} + \delta_2^k \hat{D}_{k-1} \text{ and } \hat{D}_k = D_k + \alpha \frac{COD_k}{R_k}$$

$$DO_k = C_s(k) - \hat{D}_k \quad \text{atau} \quad \frac{dDO_k}{dx} = -\frac{d\hat{D}_k}{dx}$$

Di dapat

$$\begin{aligned} \hat{D}_k &= \delta_1^k \left[L_{k-1} + \alpha \frac{BOD_{k-1}}{R_{k-1}}\right] + \delta_2^k \left[D_{k-1} + \alpha \frac{COD_{k-1}}{R_{k-1}}\right] + \alpha \frac{COD_k}{R_k} \\ &= \delta_1^k L_{k-1} + \delta_1^k \alpha \frac{BOD_{k-1}}{R_{k-1}} + \delta_2^k D_{k-1} + \delta_2^k \alpha \frac{COD_{k-1}}{R_{k-1}} + \alpha \frac{COD_k}{R_k} \qquad (3.2) \end{aligned}$$

By using equation, predictable of concentration changes of dissolved oxygen (DO) in a node (node), due to the inclusion of BOD in the previous node. (Rinaldy et al, 1979).

Social Aspects Analysis

Analysis of social aspects carried out to determine losses during urban development through the infrastructure development inconsiderate to environmental aspects, especially social aspects of society. The approach used is through Human Capital Approach or Lost Value Approach. This approach uses the market price and the level of wages on public income. This approach is applied to assess the human resources in the event of death, permanent disability, illness, absence from work as a result of an activity, in this case the urban development. This approach is called Cost of Illness Approach. (Suparmoko and Ratnaningsih, 2011).

Economic Aspects Analysis

Analysis of economic aspects was conducted to determine losses during urban development through the infrastructure development inconsiderate to environmental aspects, especially economic aspects for gone. The approach taken is opportunity costs approach or lost revenue. Relative of environment damaged by economic activity, often using the principle of opportunity cost. In economic theory there is benefit cost analysis concept, a comparison of benefits (benefits and costs). Benefit is cost avoided, while cost is the benefit for gone. To assess the benefit can be based on the demand curve for goods, then the goods benefits is the whole area under the demand curve.

Result and Discussion

Determination of Urban Area

Determination urban areas, based on city morphology that is based on physical boundary or functions limit, not by limitation admnistratif. So that the actual city boundary could be smaller than administrative borders because there is a part of city that still has the characteristics of agriculture, but it can also beyond the administrative borders because it has been integrated as the city with the neighboring region. Through observation and map image of area morphology condition of Martapura City out of administrative boundaries that have been established, even from the assigned administrative boundaries are still some areas that can not be defined as an urban area.

Determination of Urban Hierarchy

Urban Hierarchy Determination of Martapura based on the determination of urban areas based on the following indicators: (a) Main Function Area, (b) infrastructure availability, and (c) Population Growth.

Main Activities Area Function

Main activities area function is determined by the dominant land use in each village.

Table 4.1. Parameter of Main Activities Function

Parameter of Main Activities Function	**score**
agriculture, fisheries, rural settlements	1
Settlement / Housing	2
Offices, Trade and Services, Urban Activity Center	3

Infrastructure Availability

Number of infrastructure types obtained through identification of availability approach of public facilities and social facilities, consist of educational, health and worship infrastructures.

Table 4.2. Parameter of Number of Infrastructure Type

Parameter of Number of Infrastructure Type	**score**
0-3	1
4-6	2
7->9	3

Percentage of Population Growth

Percentage of population growth is obtained based on population growth average in each villages in Martapura District, West Martapura District, and East Martapura District in the last 5 years.

Table 4.3. Parameter of Population Growth Average

Parameter of Population Growth Average	**Score**
<0-3	1
4-6	2
7->9	3

The method of determining urban areas of Martapura are scoring based on the parameters of the indicators. Incorporation of score on any village will be generated which determines the total score of the villages in urban areas. Results of the analysis showed that the delineation of urban areas of Martapura not only by administrative boundaries. Based on these three parameters assessment, obtained delineation of the area based on the physical form and function of delineation boundary then obtained a population of 121 123 inhabitants. With the number of the population in an area, then the urban hierarchy for urban areas are Medium Urban Area. So that for urban infrastructure development should be adjusted based on the standards of the medium city.

Urban Infrastructure Inventory

Urban Infrastructure inventory is based on secondary data from the statistics bureau and observation to research site. In conducting an inventory of urban infrastructure, not only based on urban areas only but including the hinterland that influence urban development. Accordingly in urban infrastructure inventory, carried out in Banjar Regency depicting the city and the hinterland.

Urban Infrastructure needs and Unit Cost Variable

Table 4.11. Urban Infrastructure needs and Unit Cost Variable

Num	Variables	Unit Cost (million Rp.)	Managed Infrastructure (RHS)	Gloss
1	Education	3,563 / M2	2.100 M2	X1
2	Health	3,563 / M2	1.134 M2	X2
3	District road	0,00158114 / M	781390 M	X3
4	Residential road	0,00364657 / M	21.532,880 M	X4
5	Wooden Bridge/alley	1,517136 / M2	66700 M2	X5
6	Main Market	3,563 / M2	500 M2	X6
7	Sub-District Market	3,563 / M2	1280 M2	X7
8	Rural Market	3,563 / M2	540 M2	X8
9	Main Terminal	3,563 / M2	15000 M2	X9
10	Urban Transport Terminal	3,563 / M2	9030 M2	X10
11	Rural Transport Terminal	3,563 / M2	119750 M2	X11
12	Electrical Installation Costs	0,698/UNIT	1 UNIT	X12
13	Electricity expenses for Office per year	17,340/UNIT	1 UNIT	X13
14	Water Purification Facility	75/UNIT	1 UNIT	X14
15	Total production of Water	0,004 / L	11441920 L	X15
16	Building for water supply, and plumbing	200 / LITER	411 UNIT	X16
17	Communal septic tank	10 / UNIT	260 UNIT	X17
18	Temporary Landfill	3,563 / M2	1900 M2	X18
19	Temporary Landfill 3R	3,563 / M2	200 M2	X19
20	Sanitary Landfill	3,563 / M2	50 M2	X20
21	Sports Stadium	3,563 / M2	22500 M2	X21
22	Green Open Space	3,563 / M2	60000 M2	X22
23	Urban forest	1,7815 / M2	180000 M2	X23
24	Fish Auction Building	3,563 / M2	126 M2	X24
25	drainage	0,4 / M	56840 M	X25
26	BOD	0,024 / PPM	< 7 PPM	X26
27	DO	0,025 / PPM	> 6 PPM	X27

Explanation of the table 4.11 is as follows:

a. education variable (X1) unit cost is 3,561 / m2, while the infrastructure is handled in the form of school as 2,100 m2.
b. health (X2) unit cost for health centers, hospitals. Etc
c. RHS = Right Hand Side is expected constraint

The data required for modeling of urban infrastructure requirements and the unit cost of each these variable costs, with different units there are m2, min, km, ha, and so on. It also considere the policies and rules of law as the education budget of at least 20% of the total budget, and the health budget of at least 3-5% of the total budget. Regarding to the determination of the budget percentage for other variables the indicator is the percentage of damage. Based on data analysis, roads and wooden bridges were damaged, thus gaining greater percentage. For variables that are not damaged as concrete bridges, steel bridges and other variables will be percentage less and charge maintenance unit cost given based on the existing provisions, such as for building per m2, roads (km), electricity (kwh), water (m3), land (ha) and so on. Restriction/constraint is a constraint in terms programasi linear models that will be on the construction of namely Right Hand Side (RHS). Regarding the aspect of environmental management for river pollution are included in the model, using BOD (Biochemical Oxygen Demand) and DO (Disolved Oxygen) indicators, because both of these indicators indicate the pollution caused by household waste and human waste as the main factors of pollution in Martapura River. For the measurement unit of BOD and DO are ppm (parts per million). To fullfill the environmental standards of the river, are used in ways that allow technically at minimum cost but still does not adversely affect people who use Martapura River as a source of life. Martapura river functions into a multi-functional; as household waste sites, transportation, fish pond, water source, even a floating market tour as a tourism destination. From the analysis of Unit Price Variables are in Table 4.11.

Factors Affecting The Cost Planning Of Urban Infrastructure

Based on the analysis that has been conducted on all urban infrastructure needs, which most affect the cost of urban infrastructure in Martapura City are:

1. Social Infrastructure
   Education infrastructure, Health Infrastructure, and Sports Stadium
2. Economic Infrastructure
   District road, Residential road, Wooden Bridge/alley, Main Market, Sub-District Market, Rural Market, Main Terminal, Urban Transport Terminal, Rural Transport Terminal, Electrical Installation Costs, Electricity expenses for Office per year and Fish Auction Building.
3. Environmental Infrastructure
   Water Purification Facility; Total production of Water; Building for water supply, and plumbing; Communal septic tank; Landfill While; Landfill While 3R; Landfill; Sports Stadium; Green Open Space ; Urban forest; Drainage; BOD; and DO.

Cost Planning Model Of Urban Infrastructure Toward Sustainable Cities

The Constructed models that combines the interests of profit, people, planet (P3) which is essentially a requirement for sustainable development. A cost planning model of urban infrastructure that efficient economically becomes important to fullfill sustainability towards sustainable cities. Considering of variables existing infrastructure and urban needs of Martapura City itself, then the calculation of cost planning model of urban infrastructure that have been constructed by using the data in Table 4.11 and the software, obtained a mathematical equation as follows:

$$Z_{min} = 3.563X1 + 3.563X2 + 0.00158114X3 + 0.00364657X4 + 1.517136X5 + 3,563X6 + 3.563X7 + 3.563X8 + 3.563\ X9 + 3.563X10 + 3.563X11 + 0,698X12 + 17.340X13 + 75X14 + 0.004X15 + 200\ X16 + 10X17 + 3.563X18 + 3.563X19 + 3.563X20 + 3.563X21 + 3.563X22 + 1.7815X23 + 3.563x24 + 0.4X25 + 0.024X26 + 0.025X27$$

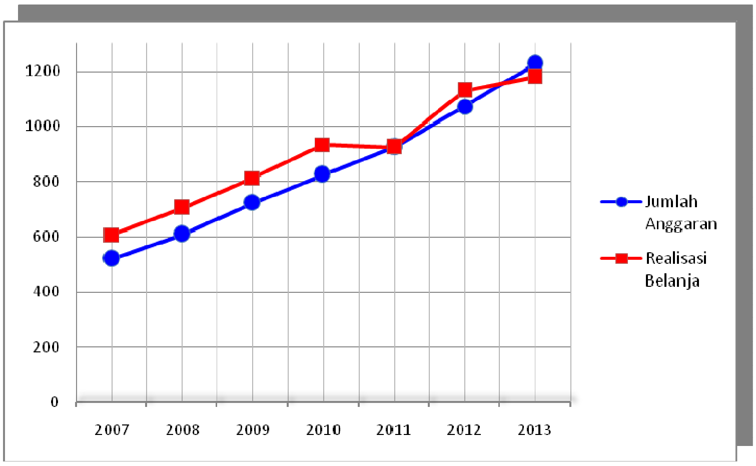
Minimum Total Cost of Urban Infrastructure

The calculations show minimum total cost for urban infrastructure development of Martapura City in 2014 is Rp. 1,105,572,000,000.00. From actual revenue and actual expenditure in 2007 - 2013 shows there are a large range of costs between revenue and expenditure of local goverment. It means the cost planning of urban development in Banjar Regency has been inaccurate as the illustration shown in Table 4.14 and Graphics 4.1.

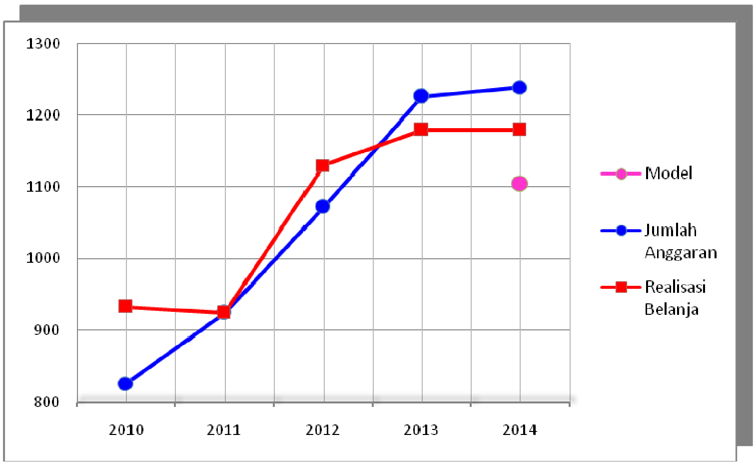
Table 4:14. Ilustration of Budget Deficit of Banjar Regency on 2007 - 2013 (in IDR. Billion)

Num	**Outline**	**Budget 2007**	**Budget 2008**	**Budget 2009**	**Budget 2010**	**Budget 2011**	**Budget 2012**	**Budget 2013**
1	**Revenue of Local Govermen**	519.16	608.79	721.67	825.33	924.52	1,071.91	1,226.64
2	**Actual Expenditur of Local Govermen**	606.53	703.83	812.80	932.99	924.62	1,130.04	1,180.30
Surplus/Deficit		-87.37	-95.04	-91.13	-107.66	-0.10	-58.13	46.34
		-16.83%	-15.61%	-12.63%	-13.04%	-0.01%	-5.42%	3.78%

when compared with conventional models, namely the budget Banjar Regency in 2014 is Rp.1,239,320,000,000.00, the model constructed more efficient 10.79%. Even more efficient compared to the actual expenditures 2014 in Graphics 4.2.



Graphic 4.1. Actual Expenditure of Banjar Regency



Graphic 4.2. Cost Planning Model to Actual Expenditure and Budget Estimates

Sensitivity Analysis

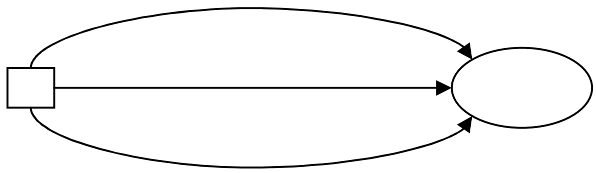
From the analysis shows this model is very sensitive to changes in unit cost. For example if there is inflation to 10%, then in general are exposed to it is the sector related to transport infrastructure, the residential road (X4) and bridges (X5). The analysis shows the minimum total cost increased 56% to Rp. 1750550000000.00 (one trillion seven hundred fifty billion five hundred and fifty million rupiah). It means that both factors are very sensitive to changes

Dual Price Analysis

From the calculation, showing dual prices (shadow price) in all constraints are zero. That is if one of the constraints (RHS) moved up one unit, then there is no effect on minimum total cost of urban infrastructure development. Understanding shadow price of two kinds: first mentioned above (in the sense of linear programing). Both shadow price in terms of the price of an item that is estimated as the price of production, so it does not include taxes, exchange rates, or other influences that cause prices to be increased compared to the base price. Based on the results of the above analyzes, the Cost Planning Model of Urban Infrastructure is made highly optimized in terms of economic efficiency and sensitivity analysis as well as dual price analysis.

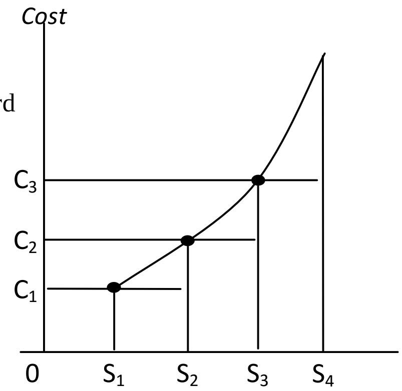
Application of Cost Planning Model of Urban Infrastructure for Environmental, Social, and Economic Aspects

Model limitations is the assumption that the statics technology and dinamics have a linear characteristic. In a fact shows that unit cost and constraints not change linearly. The models insert the environmental variable is river water quality, this model base on river water quality that the benefits is indicated by the water quality standards that have been determined. This thing related with costs that are used to reach those all standards. In micro economic theory explained that the cost of efectiveness is the lowest cost to achieve the goal by definition is expressed as follows. (Usman, 2006)



Cost of efectiveness is how much is the least cost to reach the goal

The relationship between Standard and Cost



If the standard is raised, then the cost will rise as well. Therefore, if the standard is too high, there can be economic activity is closed, so city's economy did not grow

Picture 4.6. Benefit Cost Analysis

Environmental Aspects

This cost planning model creation, insert the environmental aspects as variables through the Martapura River water pollution management approach with BOD and DO, waste management, the provision of green open space, the sanitation management, and the provision of City Forest. When the construction of urban areas concern to environmental aspects and optimized budgetary and also in technical planning considering the aspects of sustainability so the possibility for other activities with implications for region development, such as urban green, green open spaces, reduction of ecological track with reduced noise and urban pollution, and urban habitat diversity through the provision of infrastructure environmental management. All benefits from ecological improvements of infrastructure will improve the quality of the urban environment to leads to the urban environment livable.

Social Aspects

Based on Table 4.15 explained type of disease as a result of environmental damage caused by water and air pollution. For variable type of disease, the data retrieved from the data available on the Central Bureau of Statistics (BPS) through 10 major disease data at the health centers serving communities in urban of Martapura (BPS, 2014). Meanwhile the variable health costs were taken from Agustina’s Research (2015), related to the analysis of regions experiencing health costs of pollution, in determining health care costs for each disease considered to be the same for urban communities whose environment is polluted.

Table 4.15. Type of Diseases and Health Costs

No	Type of Diseases	Cases	Health Cost (Rp.)
1.	Acute Respiratory Infections (Upper Respiratory)	6.929	250.000,00
2.	Pnemonia	1.223	100.000,00
3.	Allergic Contact Disease	915	100.000,00
4.	Diarrhea / Gastroenteritis	901	100.000,00

From cost calculation of the quantity of cases with health costs for each types of diseases, obtained of public costs are Rp. 2,036,150,000.00 (two billion thirty-six million one hundred and fifty thousand rupiahs). These costs are the cost estimates that were lost during the time because of the polluted environment. Then through the provision of a model of sustainable urban infrastructure gives the benefit for the social aspects of above, due to the provision of sustainable urban infrastructure for the benefit of the increasing healthy environment in urban areas because the impact of environmental improvements, will improve the health status of the community and give them a chance to get out of poverty, due to public health gets better and the availability of adequate infrastructure, the public opportunity to strive to be more open. When people gain the ability to improve their living standards, and when the market provide new opportunities for people to work, it increases the social safety net and give contribute to community development.

Economic Aspects

On Martapura River, if in the implementation of urban development not carried over management of the river water pollution it can be seen the benefits lost through the loss of fishermen income both cages and ponds river fish, such as patin fish, bangu fish, catfish, and kind of freshwater fish. Loss of benefits due to damage to the river aquatic environment.The Analysis Calculations are shown on following table.4.16.

With the assumtion that fish farmers loss all the total income when the river can not be used as a source of livelihood anymore, so to prevent the benefits lost of Martapura river it’s really needs to be controlled to keep contributing to the improvement of people's income Rp. 806,734,425,000.00 (eight hundred and six billion seven hundred and thirty-four million four hundred and twenty five thousand rupiahs) as the GDP of the fishing pond fish.

Through the cost planning model of urban infrastructure that considers environmental aspects, can lead to increased revenue and create job opportunities. Provision of infrastructure that supports economic activity also contributed to increase the income and the urban poor employment. Although the production’s level and manufacturers’s turnover of urban communities is small, the high quantity of them in each city make their contribution to the urban economy is very relevant to consider.

Next page

Table 4.16. Fish Production

No	Description	Quantity		
1.	Pond Fish Production	46.099,11		Ton
2.	Type of Pond Fish in Kilo			
	Sea Fish			
	Manyung	Rp	16,000,000	Rp/ton
	Merah/Bambangan	Rp	30,000,000	Rp/ton
	Gulamah	Rp	899,291	Rp/ton
	White Shrimp	Rp	10,000,000	Rp/ton
	Other Shrimp	Rp	9,000,000	Rp/ton
	Other Fish	Rp	11,996,597	Rp/ton
	Public Waters			
	Gabus	Rp	70,000	Rp/kg
	Galah Shrimp	Rp	125,000	Rp/kg
	Nila	Rp	30,000	Rp/kg
	Toman	Rp	50,000	Rp/kg
	Ikan Mas	Rp	40,000	Rp/kg
	Catfish	Rp	35,000	Rp/kg
3.	Farmers Income Pond	Rp	9,286,320	Rp/ton/year
4.	Number of fish farmers in Banjar Regency	12521		Household

Sustainability Analysis

The benefits of economic, social and ecology of the sustainable infrastructure provision will lead toward to a productive city. The main intention is to achieve a productive city, where the outside city production is substituted with local city production can evolve through facilitated access to the right infrastructure provision. Therefore, the sustainable urban planning aimed at achieving social justice and the environment while enhancing people's lives. So it is necessary to have some form of sustainable city with the provision and proper management of all services/urban infrastructure. In order to the sustainable city needs to generate and manage basic infrastructure such as water, waste, roads and bridges, and other public facilities in a manner consistent with the principles of sustainable development. In other words, the city must be able to produce and distribute services economically, environmentally friendly and equitable. This is guaranteed when policies and institutions planning to use all the equipments/tools for securing resources in the future.

Conclusion

Based on research, the conclusion that answering all the research's questions are that (1) the factors which greatly affect the estimated cost of urban infrastructure based on the results of model building cost planning urban infrastructure are Supporting of Social Infrastructure, Economic Infrastructure and Environmental Infrastructure (2) Generated the cost planning model of urban infrastructure towards sustainable city, for river-based city classification with the hierarchy of mid-level city, concern to all the constraints (3) (a.) Based on environmental aspect, there is a relation between the urban infrastructure to the environmental sustainability. When the construction of urban areas concern to environmental aspect and the infrastructure budget optimized, it is possible budgeted to other activities with implications for the region development, urban greening, green open spaces, reduction of ecological track with reduced noise and urban pollution, and the diversity of urban habitats by providing of infrastructure management environment. All benefits from ecological improvements of infrastructure will improve the quality of the urban environment that leads to the liveable city. (b.) Based on the Social Aspect, with the analysis of the lost social aspects or human capital, through analytical cost of illness approach. From the analysis result showed through infrastructure provision can restore lost of cost or the communities used during the time because of the polluted environment. (c.) Based on the Economic Aspect, with analysis of economic aspect, was conducted to determine how losses are lost during the time when urban development in the provision of infrastructure not concern to environmental aspects, especially the lost of economic aspect. The approach taken is to the opportunity costs or lost revenue analysis. From the analysis showing the impact of the economy through the provision of appropriate infrastructure influential to increase community's income.

This research including all the technical restrictions of all the existing infrastructure in urban systems, as urban needs in accordance with the hierarchy of the city towards sustainable cities. This research was to construct an integrated linear economic model for management of Martapura river with multiple water quality parameters such as BOD, COD, and DO. Thus obtained the cost planning model of all urban infrastructure to determine the budget of urban development every year, considering all factors, including the management of river pollution in the river-based city, to be used during the preparation of the budget in urban planning at conceptual stage of program.
From the research as a model application described that:
" to achieve sustainable cities, improvement of the city finance capability is an absolute effort, by optimizing the city budget based on the cost planning of urban infrastructure is integrated in urban planning, and consider environmental, social, and economic aspects."

Based on cost planning model of urban infrastructure, this theory is an analysis performed to determine the optimal cost of infrastructure development deductively with the structure of spatial "Mono-Concentric Zone" (the area with a center). The center of area is Martapura City with the specificity of river-based city surrounded by hinterland and affect the development of urban areas. Each of these hinterlands, defined as the area of specialization of an activity, the location of activities is determined based on the distance from urban center (Central Business District, CBD). From each region, defined the necessary infrastructure for urban development, and analyzed the cost of each infrastructure based on location and dimensions of the infrastructure due on technical standards and the concept of sustainable cities. Assumptions in the cost planning model of urban infrastructure is that urban areas appear as a flat area, which at one point there is a CBD, as well as the technology is considered permanent.
Results from this research contribute to the urban economics that is urban planning towards sustainable cities, particularly in suburban area. As is known in Indonesia there are a lot of river-based citiy, but it was not a concern of government policy, that in urban development, especially river-based city, river pollution management aspects as a result of the development is the main thing to do, not only the physical aspects, but how improving community's living standards, especially the urban poor through the improved public health with provision of sustainable urban infrastructure. Application of this model have a positive impact on urban development and living standards of community. Because the cost planning model of urban infrastructure that consider the environmental aspects, it can increase income and job creation of the urban poor. So it is rational availability of adequate urban infrastructure affect local economic improvement.

Recommendations for further research are as follows:
(1). In order to obtain a cost estimate results are closer to the actual conditions in the analysis of variable unit cost required uniformity of the cost of the data several different periods, such as the factor of inflation and infrastructure cost index applicable for each region/city in one area. (2). The necessary research to estimate the cost of managing the pollution of the river towards sustainable cities, with emphasis on water pollution variables in addition to DO and BOD as chemical oxygen demand (COD), suspended solids (SS), non perint source polution and other variables. (3) The necessary research to cost planning of urban infrastructure involving the public and private sectors as a partnership of government.

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