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# Life Cycle Analysis of Zero Waste Management for *Jonggol* Green City

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**Abstract:** Zero waste management is believed to be one of methods to gain sustainability in urban areas. Take advantages of resources as enough as the needs and process it until the last part to be wasted is a contribution to take care the environment for the next generation. Reduce, reuse, and recycle are three simples activities which are until nowadays considered as the back bone of zero waste.

*Jonggol* green city is a new urban area in Indonesia with a 100 ha of surface area zoned as education tourism area. It is an independent area with pure natural resources of water, air, and land to be managed and protected. It is planned as green city through zero waste management since 2013. In this preliminary period, a monitoring tool is being prepared by applying a Life Cycle Analysis (LCA) for urban areas [1].

This paper will present an explanatory assessment of the zero waste management for *Jonggol* green city. The existing situation will be examined through LCA and afterwards, the new program and the proposed green design to gain the next level of zero waste will be discussed. The purpose is to track the persistence of the commitment and the perception of the necessary innovations in order to achieve the ideal behavior level of LCA.

**Key words:** Zero waste management, Green city, Life Cycle Analysis

## 1 Introduction

One of the presentations of green city is the well-managed waste resources. As a cycle, people harvest nature and will throw the waste back to the nature. In an urban area, mostly the nature could not decompose the waste naturally. The mixing between organic and an-organic wastes inhibits the decay process. In order to have better quality of life, the City Manager should prepare the waste management system.

Life Cycle Analysis is a method to monitor the persistence of the urban area to achieve its goal, including, the waste management. This paper will present an explanatory assessment of the zero waste management programs for *Jonggol* green city. The existing situation will be examined through LCA and afterwards, the new program and the proposed green design to gain the next level of zero waste will be discussed to achieve the ideal behavior level of LCA.

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# 2 Theoretical Frameworks

## 2.1 Life Cycle Analysis for Urban Development

Life cycle is a graphical tool that represents phases over a long period of time. It is represented in exponential or logistic s-curves, which are slow at the beginning, undergo acceleration, then slowing down and at the end, saturation. Lourenço [1] defined the urbanized areas in an analogy with the framework of predictions heuristics of the quasi-model of Holton. The attractiveness of mining for gold and the discovery of a new field inspired researcher to propose a utopian model of planning cycles which consists of three curves: planning, action, and living (see Figure 1). This model and the likely evolution of the gold rush were associated with an almost metaphoric mathematical model that relies on a graphical representation with an explicit visualization. This same scheme was applied to analyze and forecast the race to urbanization.

Lourenço´s model theoretically considered that during the first ten years there is an intensive planning, which will gradually decrease until reaching a minimum value, after two decades. The intensity level of the actions will increase and present a higher ratio in the second decade, and should reach a peak at the end of this period. Regarding to the intensity of the living, it is considered that the intensity has the same or slower increase ratio than the curve of the actions. At the end of the twenty or thirty years, corresponding to sixty or seventy years after the beginning of a planning cycle, the intensity of the living begins to decrease rapidly, while the intensity of planning increases quickly.

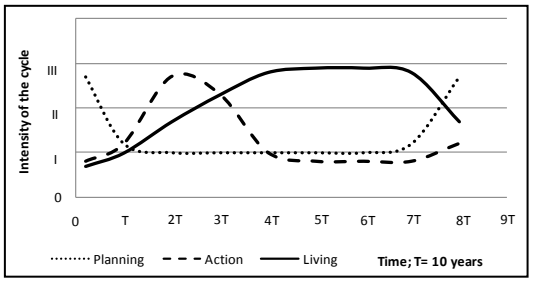


**Fig 1.** Ideal Behaviour of a Plan-process: Lourenço's Model [1]

For this model to reflect the practice, due to the result of complexities and uncertainties of the real world, is more problematic. Commonly, the planning cycles are interrupted; interpenetrate, unable to reach the normal transformation, sequential execution cycles (actions) and, subsequently experiences (living).

## 2.2 Zero Waste Concepts for Green City

The concept of Zero Waste can be resumed as an integrated waste management. The principle of waste management is minimizing the production of waste from the whole production of people activities. It needs very careful examination in order to determine the most possible implementation of 3R in the each step of the activity. Waste management should be well-planned, well-executed, well-controlled, and well-evaluated in order to be well-implemented by the community. The application of the concept of zero waste in the 3R General Guidelines Settlements and Regions are divided into two methods, those are: (1) handling of waste should no longer be based solely on the collection activity of transport and garbage disposal and (2) handling of household waste and the region area is expected to implement the minimization efforts by reducing, reusing and recycling waste generated.

Recently, green cities is believed will enhance the quality of life of the inhabitants and visitors. Since cities must be made more attractive places in which to live and their ecological footprint must be reduced [2].To be green urban areas based on zero waste concepts, the City Manager should consider to the physical elements of land use, waste management, green open space, signage and car-free zone in the proposing master plan [3]. Green design is the obligation of urban designers to the society. Architects and urban designers should have depth thinking if the action or inaction will make a better place or not. Not only influence todays living but also in the future. The design should be viewed cumulatively between the potential good and bad outcomes [4]. Green architecture will have design which optimized the environment in forming the places an allowing people to become more in touch with the environment in which they live [4]. There are some cities who has implemented zero waste concepts in their solid waste management city, those are: San Francisco, Stockholm, and Adelaide. According to zero waste research, San Francisco becomes closest to achieving zero waste than the other two cities due to its emphasis on reusing solid waste. San Francisco has struggled to involve all of the citizens in order to separate the trash and recycle all of possible trash which still can be source for other goods [5].

## 3 Research Methodology

The model consists of three curves: planning, action and living. To estimate the intensity of each phase, there are some factors influence, those are: (1) the intensity of planning is indicated by the presentation of urban strategy, planning frameworks, directives, planning proposals, new bodies, and urban development visions which have relation with the projects, (2) the intensity of action is indicated by the number infrastructures construction, public participation, and amount of investment, (3) the intensity of living is indicated by the number of people living and visiting, and the economic and social activities. Figure 2 shows the flow work of this methodology which is revisited from Lourenço (2003) and Alvares (2008). The factors will be checked whether present or not present in order to determine the intensity of each phase (low, medium, high). The graphic portrayed is a quasi-dynamic model for urban area planning process.

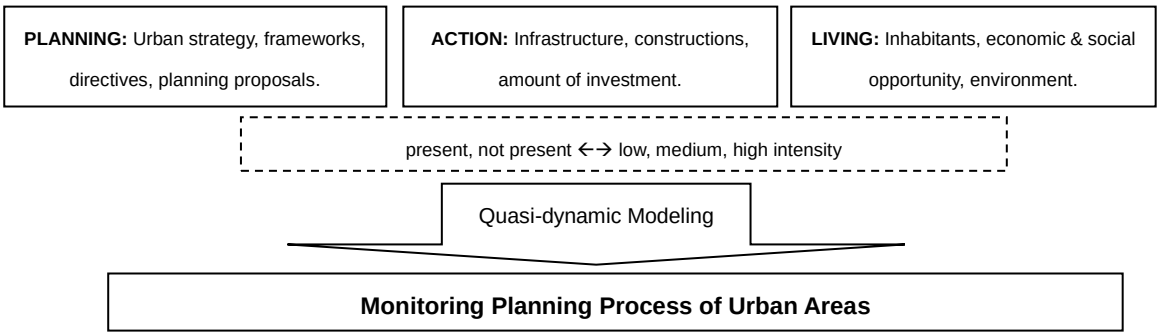


**Fig 2.** The flow work of the model [6]

The justification of the intensity of the cycle for each phase is done according to the representation of the factors which appear in the urban plan-process that can be examined through the plan-process history of the study case. For example, for the planning phase, when the city puts forward a vision and mission, the planning proposals, and urban strategy, the intensity of the planning phase is justified in the high intensity. When the city has a new urban image that is mostly based on the planning proposals of the action plan, the

intensity of the action phase is justified in the high intensity. Afterwards, in the living phase, if the data on visitors shows that not much people come to enjoy the new urban image, the intensity of the living phase is justified in the medium intensity. Through this graphical monitoring, the city managers can do an assessment to find out the problems and try to solve them as quick as they can to avoid dry run of the investment and infrastructure building.

| Year | Planning | Present/not | Action | Present/not | Living | Present/not |
|---|---|---|---|---|---|---|
| 1975 | | | | | | |
| 1980 | | | | | | |
| 1990 | Vision & Mission | √ | | | | |
| 1995 | Urban strategy | √ | | | | |
| | Framework | √ | | | | |
| 2000 | | | Constructions | √ | | |
| 2005 | | | Investments | √ | | |
| | | | New urban image | √ | Number of visitors | - |
| 2010 | | | | | Economic opportunity | - |
| 2015 | | | | | | |

√ : present, - : not present

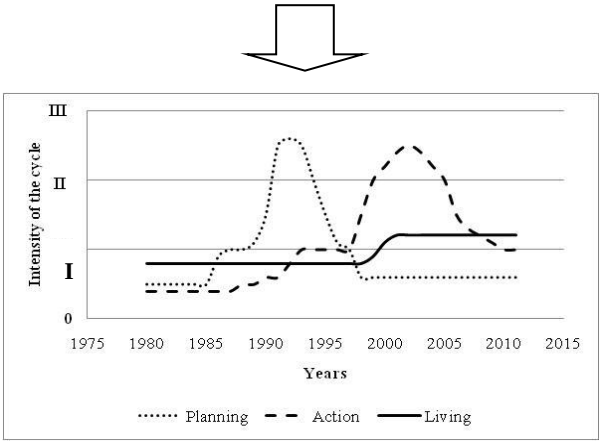


**Fig 3.** LCA graph [6]

The justification process of the intensity of the cycle might present the most relevant difficulties in doing the analysis. The subjectivity when justifying the intensity of the cycle should be minimized by the evaluator. They should try to fairly apprehend the big picture to get the assessment results clearly similar to the field condition. The objectivity of the analysis can be achieved if the complete and historic data can be collected and verified. It should be done carefully in order to help researchers and city managers understand the behavior of the city plan-process during the specific period to be assessed.

## 3 Results and discussion

### 3.1 *Jonggol* Green City

Jonggol Green City is located in the Cibodas and Singasari Village, Jonggol District, Bogor Regency, West Java Province. It is 60 km southeast of Jakarta, Indonesian Capital City. Jonggol green city is the master plan of Madinatulquran Islamic Boarding School which planned to be education and tourism area. The area of 100 ha is divided into three zones of Medina, Sunda, and Mecca. Medina zone represents the modernity of Islamic education, Sunda zone represents the traditional Islamic education with *sundanese* village

atmosphere, and Mecca zone is a green hilly area as an academic resort. The area will be completed with several facilities such as dormitory, market, and hospital to support people activities and attract people to come.

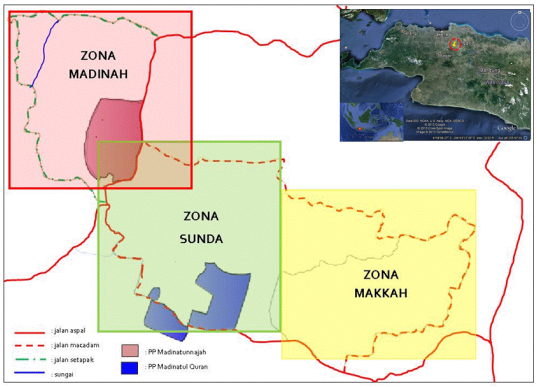


**Fig 4.** Zoning of *Jonggol* Green Islamic City [7]

Nowadays, Sunda Zone is the most developed area. There are junior high school Islamic boarding houses is called as MQ I and Islamic academy for teachers is called as MQ II. Those two schools have been opened since 2013. The Junior high school has a mosque, sport yard, boarding houses, class rooms and a canteen. Those facilities support the daily living of 130 students who stay in the school every day and have to do several activities. In between of their schedule, the students can participate in entrepreneur activities like planting and farming. Besides students, MQ I area has to support the living of 50 teachers and their families, and 20 employees.

**Fig 5.** Classrooms, boarding houses, mosque, and open canteen in MQ I [8]

The academy for Islamic teachers provides education from foreign teachers such as from Medina, Saudi Arabia. It has permanent students who will stay in this school for one year and temporary students who participate in the short course programs. Students also can do several activities such as farming and studying mechanic. Today, MQ II has to support 50 students and 10 teachers and their families.

### 3.2 Zero Waste Application in *Jonggol*

The green and zero waste concepts have been implemented in *Jonggol* Green City. Those are walking area, eco-friendly buildings, farming, and water conservation. Walking area is built to connect one building to other buildings in one zone. Eco-buildings are built with wide windows in each rooms and the using of local materials such as bamboo and coconut woods. Farming activity has been proposed as an effort to gain self-sufficiency in food which is supported by waste separating activities which can produce compost fertilizer. The spring water has been conserved as the water resources for daily activities.

Although green and zero waste concepts have been implemented, the City Manager does not have waste management planning. The infrastructure to process waste water and solid waste has not been well-built.

**Fig 6.** Grey water from kitchen and bathrooms (left), solid waste dump, waste bins [8]

However the willingness to keep the area clean by providing the waste bins at certain areas as the waste sources is well-implemented. During period 2012- 2015, the LCA can be portrayed as below.

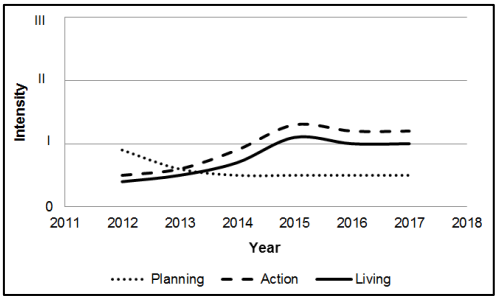


**Fig 7.** LCA of waste management in *Jonggol* recently, without planning

The LCA graphic shows that even without massive planning, the City Manager try to keep the area to be cleaned. Through the several actions and the willingness to clean the place, the intensity of the action and living is higher than the planning. However, due to the area development and the increasing number of people who will live there, the waste management planning is necessary to be proposed.

In order to mirror the ideal behavior of plan process, the City Manager should start the new planning in 2015, continuing with the building of waste processing infrastructure and implementation for the program which involving people. Due to the large of the built-up area for next few years, the intensity will be in the second level, however, the consistence and persistence of the commitment and the perception of the necessary innovations in order to achieve the ideal behavior level of LCA might be achieved. Here is the ideal graphic of LCA for *Jonggol* waste management planning.

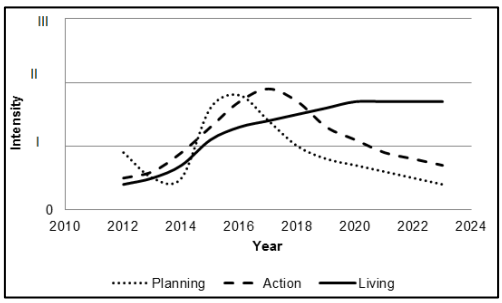


**Fig 8.** Ideal behavior of *Jonggol* waste management which want to be achieved

3.3 Proposal of *Jonggol* Zero Waste

To solve the existing waste problem and to prepare the area development for the next few years, the proposal of waste management will be proposed. The first step is mapping the waste sources. In *Sunda* zone, there are three development spots area: new traditional market with 90 kiosks and about 200 people will stay

there during the day, MQ II with 60 inhabitants, and MQ I with 200 inhabitants. Waste production is calculated with assumption one person produce 1 kg waste every day, divided into organic (65%) and an-organic waste (35%). For traditional market waste, it is assumed that 90 kiosks with 200 people will produce 300 kg waste equal to 1 $m^3$ waste and the proportion of organic waste is 80% and an-organic waste is 20%. Here is the waste source map in Sunda Zone, Jonggol Green City.

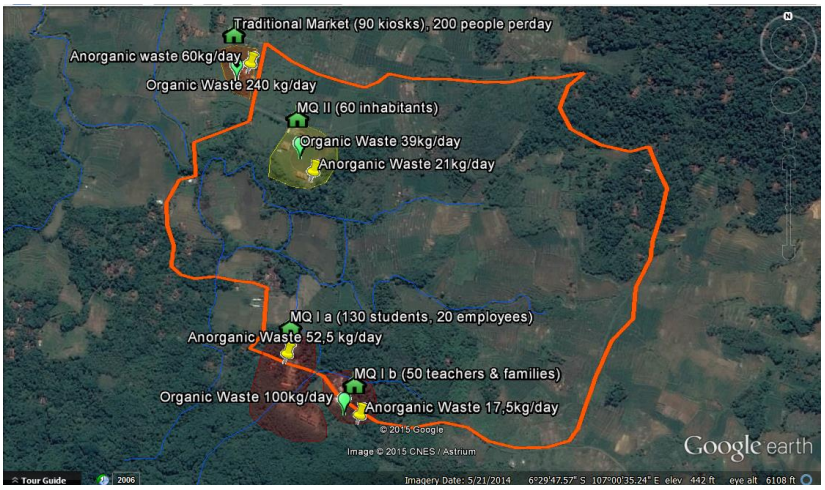


**Fig 9.** Solid waste source map of Sunda Zone, Jonggol Green City

The idea for the waste management program is separating the waste between organic and an-organic, composting the organic waste or producing biogas, building bank of waste system, collecting an-organic waste and selling to recycling factory. In the area of traditional market is proposed to be built biogas plants to process organic waste. The biogas can be captured as the fuel for the stoves in the kitchens or to produce electricity for the lamps. In this area, the central of bank waste will be built, with pressing machine to press an-organic waste before sold to the recycling factories. In the area of MQ II is proposed to be built composting plant and bank of waste. The compost fertilizer will support the farming activities and the collection of an organic waste will be transferred to the central bank of waste in the traditional market area. In the area of MQ I, is proposed to be built biogas plant to decay the organic waste from the kitchens, and bank of waste to collect an-organic wastes. The diagram plant can be seen on the figure below.

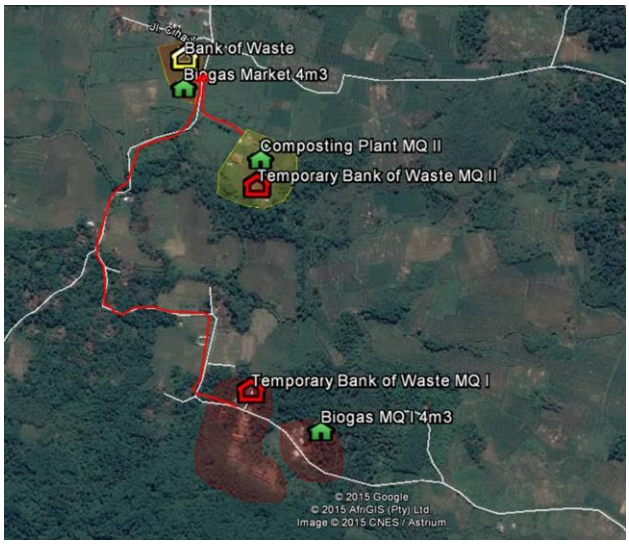


**Fig 10.** Solid waste management infrastructure proposal for Sunda Zone, Jonggol Green City

By having this planning proposal for the solid waste management, the planning phase of the LCA in 2015 respectively will reach higher intensity. Hopefully with the momentum of the traditional market opening, the solid waste handling infrastructure will be built in the middle of 2015. As a result, *Sunda* Zone will have an integrated solid waste management.

## 4 Conclusions

*Jonggol* Green City has not had planning strategy for waste management. The waste handled is done in a traditional way with the willingness to keep the area clean. The LCA shows although there is no “planning”, the “action” and “living” show higher intensity. However, in the future, the development of this area will face waste problems as the impacts of increasing number of people who live or visit there.

Through green city and zero waste approach in designing the waste management proposal, the ideal behavior of LCA can be mirrored in the medium level. The waste management proposal consist of; separating between organic and an-organic wastes, composting the organic wastes or producing biogas, building bank of waste system, collecting an-organic wastes and selling to recycling factories. By examining the LCA, the City Manager could understand the behavior plan-process of the solid waste management in *Jonggol* Green City. Besides could monitor the persistence and the commitment to implement the program. Understanding the LCA will help the City Manager to take the next step to revise the planning or urban strategy in order to create a better place.

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