# LEAN GREEN SYSTEM DESIGN AND CONTINUOUS IMPROVEMENT WITH LEAN-SIX SIGMA METHOD AND QUALITY FUNCTION DEPLOYMENT IN SURABAYA CITY ENVIRONMENTAL DEVELOPMENT

Endang Prihatiningsih<sup>1</sup>,Nyoman Sri Widari<sup>2</sup>, Siti Sri Murni<sup>3</sup>

<sup>1</sup>Management Department, University of WR Supratman Surabaya; <sup>2</sup>Chemical Engineering Department, University of WR Supratman Surabaya; <sup>3</sup>Management Department, University of WR Supratman Surabaya, INDONESIA.

end.prie@gmail.com<sup>1</sup>, ecsitisrimurni@gmail.com<sup>3</sup>

### ABSTRACT

Progress of Surabaya city development is increasing rapidly from time to time, so it requires the handling of cleanliness and landscape of the city seriously, effectively and efficiently, because the progress of city development without accompanying handling and handling the impact, such as hygiene and city park problems will be disastrous for the people of Surabaya. As the construction of multi-storey buildings in Surabaya, it can minimize green open space (RTH) and of course can also reduce the area for greening the city so indirectly the balance of urban ecosystems disrupted. To overcome the various problems of cleanliness and landscaping of Surabaya city, this research will be designed lean and green system and Continuous Improvement for Surabava Environment Agency by Lean Six Sigma method and Quality Function Deployment, which can help PEMKOT Surabaya to overcome the problem of handling garbage and city park. The lean method is used to identify the inefficiency of the public service system, the Lean Six Sigma method is used to measure the performance of the existing service system, while the Quality Function Deployment method is used to design the cleanliness and landscaping system of Surabava city, in accordance with the needs of the people of Surabaya. With the integration of the two methods above is expected to be realized Surabaya city cleanliness and gardening system that is effective, efficient, and has a high quality. So the award, such as "Community Good Works" from American Society for Quality (ASO) obtained by Kingsport city in Tennesseee state, USA, because the city government uses the concept of Six Sigma to improve the handling of waste, can also be obtained in the form of awards adipura Surabaya. From the result of Quality Function Deployment attribute service that has the highest value is the city park as a place of entrepreneurship development; city parks as community development activities; city parks as a means of environmental, cultural, social and art development; the adequacy of the number of parks, forests and green spaces; repair and maintenance of waterways and rivers. All attributes must be implemented to fulfill the wishes and needs of Surabaya residents for hygiene and garden services in Surabaya. Based on activity mapping process for current state condition, hygiene service process in Surabaya city is still not optimal, in because there is still a lot of garbage that has not been transported to TPA, and pengelolahan independently by society still little. From the results of the waste identification obtained the waste that has the highest weight in the SME cleanliness service system by DKP Surabaya is waiting (weighting 3.7), inappropriate processing (weight 2.7) and unnecesarymotion (weight 2.3. Based on the activity mapping process note that non value adding activity on the cleaning service system in DKP Surabava still has a large proportion. To know the root cause of waste in this study used fishbone diagram for each type of waste.

**Keywords:** Lean and Green System, Continuous Improvement, Lean Six Sigma, Quality Function Deployment

### **INTRODUCTION**

Surabaya, a city with an average temperature of 30 degrees Celsius, consists of 31 districts, 163 urban villages is the second largest city after Jakarta. The problem facing Surabaya city today is the problem of handling cleanliness and city security that has not been optimal. The volume of waste production in Surabaya increased by 9,677.83 m3 / day in 2011 and in 2015 to 9,475.21 m3 / day, in line with the development of the city as the data recap in Table 1 (Data of Sanitation and Gardening Department of Surabaya, 2016). With the increasing number of garbage produced by Surabava residents, the final waste disposal site (TPA) in Surabaya city, the more can not accommodate the waste generated by the residents. If the problem of garbage disposal produced by Surabaya residents is not handled optimally, it could be Surabaya city will have a mound of garbage in one corner of the city, which can be a source of disaster as happened in Leuwigajah city of Bandung. The disaster that occurred at Leuwigajah Bandung was a disaster that opened the eyes of all Indonesian citizens, how bad is the coordination of waste management in Bandung (and possibly other cities in the country)? For comparison, the city of Kingsport in the state of Tennesseee, USA, was awarded the "Community Good Works" from the American Society for Quality (ASQ) because the city government uses the Six Sigma concept to improve its waste management.

No	Description	2011	2012	2013	2014	2015
1	Waste Production Volume (m3 / day)	9.677,83	9.376,73	9.601,36	9.185,94	9.475,21
2	Number of waste handled in TPA (m3 / day)	3.833	3.898	4.651	4.853	4.926
3	Percentage of Waste handled in landfill (percent	40%	42 %	48%	53%	52%

Table 1. Garbage Production Volume and Number of Waste Handled at TPA Surabaya CityYear 2011-2015

Source: Department of Sanitation and Gardening,2016

In addition to the garbage problem, other problems facing Surabaya city and possibly other cities in Indonesia are the problem of city park. If we observe the streets in the city of Surabaya, the number of trees or city park that serves as a producer of O2 in the city of Surabaya is fewer in number. The city of Surabaya is located near the coast and with an average temperature of 30 degrees Celsius, if the handling of garbage and city landscaping is not implemented properly, what will happen is the natural scenario caused by both of these things. Based on the background, in this research will be designing public service system in the cleanliness and landscape of the city of Surabaya with Lean Six Sigma and Quality Function Deployment. With the approach of both methods, expected handling system cleanliness and landscaping Surabaya city can be effective, efficient, and have the flexibility and high quality, and can realize the implementation system.

### **RESEARCH PURPOSES**

The purpose of this research is as follows:

- 1. Create a Big Picture Mapping for the service system of environmental arrangement and cleanliness of Surabaya city by Surabaya Environment Department.
- 2. Create a value stream mapping process of public service for handling cleanliness and

environmental arrangement of Surabaya city, with the aim of identifying value adding activity and non value adding activity in the service process.

- 3. Identify the quality characteristics of urban hygiene handling and management system in accordance with the needs and expectations of the people of Surabaya by using the method of Quality Function Deployment.
- 4. Identify the factors causing failure of hygiene handling system and environmental arrangement of Surabaya city.
- 5. Designing cleanliness and environmental management system of Surabaya city with Lean Six Sigma approach and Quality Function Deployment.
- 6. Develop a public service system for cleanliness and environmental arrangement of Surabaya city that excellence and nearly perfection, so that the needs of Surabaya people will be clean, green, and beautiful city can be fulfilled.



# **RESEARCH METHODOLOGY**

### **RESEARCH BENEFITS**

The result of this research is to give an alternative of cleanliness and environment management system of Surabaya city that excellence and nearly perfection. Due to the urban sanitation handling and management system designed with Lean Six Sigma approach and Quality Function Deployment, will provide the following benefits:

- 1. Cleaning and environmental management system of Surabaya city will be efficient and effective, without sacrificing flexibility and quality.
- 2. Improving the productivity of public service system of Surabaya City Sanitation and Environment Department.

### **RESULT AND ANALYSIS**

#### **Customer Satisfaction Performance Analysis**

This performance level analysis aims to determine the performance attributes - hygiene and urban park attributes that have been implemented. In this study, the stage of performance level analysis is the Surabaya society's assumption of the services provided by the Government of Surabaya. From the results obtained, it can be seen the assessment of the Surabaya community related services provided. More data on performance levels in the form of mode values, can be seen in the table below:

No.	Customer Requirement	Customer Satisfaction
1	Environmental cleanliness level in Surabaya	4
2	Level of beauty of Surabaya City	4
3	Sufficiency of hygiene service facility (garbage bin, truck hauling, landfill	4
4	Adequate number of park / forest / green space city	3
5	Janitorial services and city parks as social support systems	4
6	Improving city environment	4
7	Management of compost and municipal waste system	4
8	Repair and maintenance of waterways and rivers	3
9	Reduction of environmental pollution	4
10	Development and Development of parks, forests, green spaces of the city	3
11	Park city as a place of entrepreneurship development	2
12	As an activity development facility for the community	3
13	Reconstruction And reorganization of social infrastructure	3
14	Reduction of environmental and social damage	4
15	As a means of developing cultural, social, tourism, and art environments	3

#### Table 2. Customer Satisfaction Performance

#### Waste Identification

Waste identification stage is the stage of knowing the waste that often occurs in the process of cleaning services in DKP Surabaya. For the identification of the waste, the researcher made the questionnaire given to the supervision in every process. Questionnaires or questionnaires were prepared with the objective to determine the weight of waste by considering the intensity factor of the occurrence of waste. The waste identification results are as follows.

Table 3.	Waste Identification	l
I abic 5.	vaste fuentification	L

No	Wasta	Respondents						Weight	Durching	
	w asie	1	2	3	4	5	6	weigni	Kunking	
1	Over Production	1	1	2	1	2	1	1,3	7	
2	Waiting	4	4	3	4	4	3	3,7	1	
3	Transport	2	2	2	2	2	2	2	5	
4	Inappropriate Processing	3	3	3	3	2	2	2,7	2	
5	Unnecessary Inventory	2	2	2	1	1	1	1,5	6	
6	Unnecessary Motion	3	2	2	2	3	2	2,3	3	
7	Defects	3	2	2	3	2	2	2,3	4	

Table 4. VALSAT

		Tools								
Waste	Weight	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification matrix	Decision Point Analysis	Phisical Structure		
Over Production	1,3	1,3	3.9		1,3	3,9	3,9			
Waiting	3,7	33,3	33,3	3,7		11,1	11,1			
Transport	2	18						2		
Inappropriate Processing	2,7	24,3		8,1	2,7		2,7			
Unnecessary Inventory	1,5	4,5	13,5	4,5		13,9	4,5	1,5		
Unnecessary Motion	2,3	6,9	20,7	6.9		20.9	6.9	2.3		
Defects	2,3	2.3								
Total Bobot		90.6	71.4	23.2	4	49.8	29.1	5,8		
Ranking		1	2	5	7	3	4	6		

So based on the VALSAT (Value Stream Analysis Tool) method, then the mapping tool used is Process Activity Mapping

### Process Activity Mapping Waste Management in Surabaya City

Process activity mapping (PAM) is used to find out all activities that take place during the process of cleaning service and first in DKP Surabaya. This tool aims to eliminate unnecessary activities, identify whether a process can be more efficient, and look for improvements that can reduce waste. In this research PAM is used to map activities in DKP cleanliness service system conducted based on observation and brainstorming with related parties. Figure 1 shows a Flow Chart or Process Activity Mapping for the present condition and the responsibility for garbage collection and transport in Surabaya is as follows:





Figure 2. Process Acitvity Mapping

### Cause and Efect Diagram

Cause and Effect analysis (fishbone diagram) is a tool that can be used to identify the root cause of the problem. Fishbone diagram in this study is used to analyze the root cause of waste that occurs in the cleaning service system in Surabaya. The charging of the waste questionnaire is addressed to employees who really know the condition of the service process. The result of the questionnaire is a critical waste of 7 waste that occurs. From these results can be built a cause and effect analysis to identify the impact and root causes. Cause and effect analysis in this research can be seen in figure 3 as follows:



Figure 3: Fishbone Diagram for 7 waste

## CONCLUSION

The conclusions drawn from the research on hygiene service system at Surabaya City Department of Hygiene and Gardening (DKP) are as follows:

- 1. From the result of Quality Function Deployment attribute service that has the highest value is the city park as a place of entrepreneurship development; city parks as community development activities; city parks as a means of environmental, cultural, social and art development; the adequacy of the number of parks, forests and green spaces; repair and maintenance of waterways and rivers. All attributes must be implemented to fulfill the wishes and needs of Surabaya residents for hygiene and garden services in Surabaya.
- 2. Based on activity mapping process for current state condition, hygiene service process in Surabaya city is still not optimal, in because there is still a lot of garbage that has not been transported to TPA, and pengelolahan independently by society still little.
- 3. From the results of the waste identification obtained the waste that has the highest weight in the SME cleanliness service system by DKP Surabaya is waiting (weighting 3.7), inappropriate processing (weight 2.7) and unnecessarymotion (weight 2.3).
- 4. From the Value Stream Analysis Tool, the mapping tool that has the highest value is the activity process mapping.
- 5. Based on the activity mapping process note that non value adding activity on the cleaning service system in DKP Surabaya still has a large proportion.
- 6. The study used fishbone diagram for each type of waste to know the root cause of waste in.

### REFERENCES

- [1] Bounds, G., Lyle, Y., Mel, A., & Gipsie, R. (1994). *Total quality management: Toward the emerging paradigm*. Singapore: McGraw-Hill.
- [2] Brue, G. (2002). *Six sigma for managers*. Jakarta: Canary.
- [3] Christopher, C, (1995). *Strategies for reducing cost and improving service*. London: Penerbit Prentice Hall.
- [4] Dale, B.G., & Plunkett, J.J. (1990). *Managing quality*. Great Britain: Philip Allan.
- [5] Hines & Taylor. (2000). *Strategy & excellence in the supply chain*. London: Penerbit Prentice Hall.
- [6] Hines, P. (2000). *Value stream manpgement: Strategy and excellence in the supply chain*. Great Britain: Prentice Hall.
- [7] Luki, T. (2003). Evaluation and improvement of production system by minimizing waste in value stream as an effort to lean production in pt behaestex. Thesis: TI ITATS.
- [8] Michael, L. G. (2000). *Lean six sigma: Combining six sigma quality with lean speed*. New York: Mc Graw Hill.
- [9] Miranda, T., & Amin, W. (2002). *Six sigma: Overview, application of processes and methods used for improvement: GE MOTOROLA*. Jakarta: Harvarindo.
- [10] Nurhayati, A. (2003). *Lean method Approach to reduce waste by using value stream mapping tool*. Thesis : TI ITATS.

- [11] Onho, T. (1995). Just in time in Toyota System . Jakarta: Gramedia Pustaka Utama.
- [12] Pande, P. S., Neuman, R. P., & Cavanagh, R. R. (2002). *The six sigma way how GE, Motorola, and other well-known companies hone their performance.* Yogyakarta: Andi Publisher.
- [13] Radovic, I., & Mac, C. (2004). *Lean six sigma in shipbuilding*. USA: University of New Orleans.
- [14] Rahaju, S. (2006). *The application of six sigma method and value stream management on the quality control of ship production process*. Jakarta: Research report of Young Lecturer.
- [15] Richardus, E. I., & Richardus, D. (2002). *The concept of supply chain management*. Jakarta: Gramedia Widya Sarana Indonesia.
- [16] Shendy, R. (2006). Application of lean method to evaluate and reduce waste in production process in PG. Surabaya: Thesis, TI ITATS.