

Solid Wastes and Green Open Space Management in the Green Hospital Perception

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Abstract

The aims of the research is to analyze outdoor environmental comfort, sort of non-medical solid wastes, and green open spaces (GOS) in the Public Regional Hospital of Pare, Kediri regency, Indonesia. The research respondents were 137 persons of hospital occupants; consists of patients, doctors, hospital staffs, and visitors. Field observation in hospital GOS was carried out to measure the tree diameter; the data were used to estimate the area of tree shading. Thermal comfort of outdoor environment analysis involved air temperature and air relative humidity in the form of Humidex. Results showed that 44% respondents stated that the sort of non-medical solid wastes has been in accordance with the principles of green-hospital.

Keywords: Green Open Space, outdoor environmental comfort, thermal discomfort index

1. Introduction

The comfort of environment is one of the significant factors in determining the level of satisfaction of patients and visitors of a hospital, besides the clinical and medical services (Harris et.al., 2009). Moreover, environmental improvement, in order to create more comfort hospital environment, results positive impacts on human performances and improve the patients and visitors comfort during their stay in the hospital (Kolcaba et. al., 2006).

The development of knowledge and understanding about health today gives a new high concern about environmental health. One of four human diseases in the world is the effects of the polluted environmental exposure (Wilburn, 2007). The healthcare industries give high contribution in producing more than 2.4 billion tons of solid wastes (garbage) in a year, and the highest energy consumers in the world (Sattler and Hall, 2007). High garbage production and high energy consumption have impacts on environmental health and human health in the hospital area. The hospital which is responsible for caring all patients from diseases, should take more responsibility in maintaining the environmental qualities, improving the health of patient, visitor and employee (Harris et. al., 2009).

Implementation of the Green Hospital principles targeted on 2020 in the whole nations in the world has been declared, and Indonesia has agreed it. Through various scientific forum on the *Green Hospital* facilitated by the Indonesian Ministry of Health (Depkes RI, 2012), have been appointed that implementation of the green hospital principle in Indonesia are targeted at 2020.

The Kediri regional public hospital located in the Pare sub-district is functioned to serve communities health from the Kediri regency and its surrounding areas, the daily patients about 700 persons. This hospital has been targeted into the Green Hospital on 2020. At the present time the hospital management still developing the appropriate system in handling their solid wastes and improving outdoor environment comfort through the development of Green Open Spaces.

The management of the non-medical solid wastes in this hospital is based on the Decree of the Indonesia Minister of Health No.1204/Menkes/SK/X/2004 about the requirements of the hospital environmental health. The implementation of the policy should be conducted continuously in order to improve the effectiveness and the efficiencies of solid wastes management (Atik, 2011).

Based on Akter research in (1999) regarding hospital waste in the city of Dhaka, Bangladesh, showed that both clinical waste and other types of waste generated by the hospital would affect residents and the environment nearby (Akter, 2009). Moreover, according to (Arianti, 2013), providing the public awareness of green open spaces and infrastructure is a means to improve the quality of the environment as well. This green space could be an open area of the elongated area / line and / or groups, whose use is more open, a place to grow plants, whether grown naturally or deliberately planted. Pare public hospital is hopefully becomes one of the green spaces that can improve the convenience of the patients, the visitors and the hospital staffs themselves. Both of these two

important factors, non-medical solid wastes management and green open space, are considered in improving the quality of Pare Hospital Green Hospital. And also as important factor that affects the comfort of patients, visitors and staffs. Therefore it is necessary to do research on non-medical waste sorting and analysis of vegetation as green open space parks in determining the comfort of the hospital environment in Pare Public Hospital in Kediri regency, Indonesia.

2. Research Method

The research was carried out at the Pare Regional Public Hospital, Kediri regency, during September 2012 to May 2013. This descriptive observational research was focused on non-medical solid wastes sorting, collecting and transporting processes, and on tree vegetation analysis of the green open spaces in the whole area of the hospital.

2.1 Outdoor Environmental Comfort of The Pare Hospital

The comfort of the hospital environment includes some indicators; they are (1) no bad odors, (2) air temperature and relative humidity corresponds to endurance, (3) occupants feel comfortable on the hospital environment.

Data analysis is carried out by using the Microsoft Excel 2007 for Windows.

The occupants' perception on environmental comfort in Pare Hospital is analyzed through the descriptive analysis of questionnaire results about the non medical handlings. The use of questionnaires for the evaluation of non-medical solid wastes management at the hospital are advised periodically (Ferdowsi et. al., 2012).

2.2 Tree Vegetation in Green Open Spaces

Green open spaces in the Pare Hospital are classified into five locations, namely Cempaka Park, Pav Park, Gardens, Cendana II Park, and ICU Park. The tree in the GOS are measured its stem diameter at the breast height (DBH) (Hairiah and Rahayu, 2007). DBH is used to estimate the area of tree shading.

$$D = \pi \cdot r^2$$

D : shading dominance (cm²)
r : tree radius.

2.3 Air Temperature and Relative Humidity

Abiotic factors affecting the outdoor environmental comfort are air temperature and air relative humidity.

The measurement is done three times a day, in the morning, noon and evening. The measurement is carried out on working days and calculated the average monthly. Humidity is a significant factor affecting the environmental comfort (Burke et. al., 2006), therefore it is used the Humidex score. This Humidex score method combines air temperature and relative humidity to produce a measure that describes the temperature felt by a person in a certain condition (Kosatsky et. al., 2005). The Humidex score describes degree of environmental discomfort (Burke et. al., 2006).

$$\text{HUMIDEX} = T + 5/9 * \left((6.112 * 10^{\left(\frac{7.5 * T}{237.7 + T} \right)} * H / 100) - 10 \right)$$

(T = air temperature (°C) ; H = relative humidity (%))

3. Finding and Discussion

3.1 The Sort of Non-medical Solid Wastes

Non-medical wastes in the Pare hospital comes from the administration offices (paper), medical services room, inpatients room, and kitchen wastes (wrapping residues, food wastes, and others). A lot of plastic wastes are generated in the surgery room, Pavilion and Cendana II, Inpatient room. In addition to generate plastic wastes, the surgery room also generates paper and non-paper organic wastes. The Pavilion room also produces a lot of paper and plastic wastes. The most of non-paper organic wastes are produced in the kitchen and hospital gardens (Table 1). Non-medical organic wastes of the non-paper can be used as materials for composting. Badran and El-Haggag (2006), and Damghani et al. (2008) describe the processing of organic waste into compost, and this can be done for optimizing the waste management.

The survey results presented in Figure 1f show that about 44% of the respondents consider the sort of non-medical solid wastes in the Pare hospitals had been in accordance with the Green Hospital principles. However, these green hospital principles are not yet understood well by the communities, so that about 50% of respondents are not understanding about the implementation of the green hospital principles in the Pare hospital.

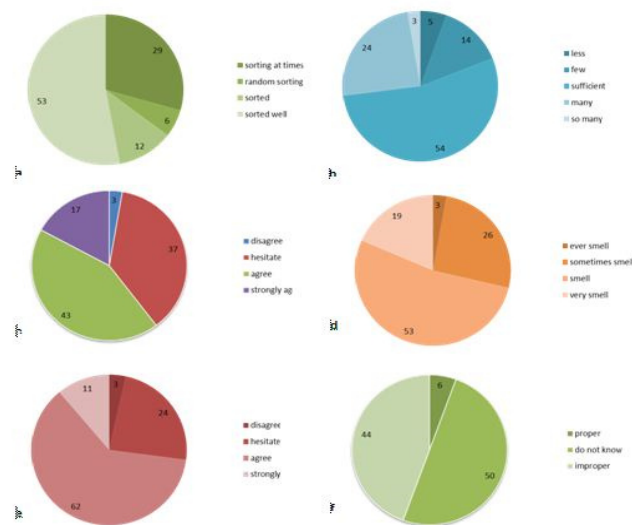


Figure 1 Personal perception about the outdoor environmental comfort in relation to the non-medical solid wastes management in the Pare Hospital (percentage of respondents).

(a) Sortation of non-medical solid wastes, (b) Sufficiency of wastes basket and container, (c) Wastes sort resulted in environmental amenities, (d) Wastes odor in outdoor environment, (e) Air temperature and relative humidity determined, outdoor environmental comfort, and (f) Conformity to the *Green Hospital* principles.

Table 1. Non-medical solid wastes in the Pare Hospital, Kediri

No	Room	Plastics (kg)		Paper (kg)		Organic materials non-paper (kg)	
		Mean	stdev	mean	stdev	mean	stdev
1	The east-side clinic	2.29	±1.32	1.54	±0.97	5.71	±3.00
2	FNAB	-	-	-	-	-	-
3	The west-side clinic	0.89	±1.03	0.48	±0.70	1.75	±1.44
4	Pavilliun (VIP rooms)	3.26	±1.53	2.12	±1.22	9.74	±4.34
5	UGD/IRD	2.82	±1.62	1.22	±0.74	5.85	±2.67
6	ICU	1.03	±0.70	0.64	±0.43	2.10	±1.82
7	O.K	4.32	±1.83	2.35	±0.79	10.65	±2.40
8	R.R	0.19	±0.16	0.24	±0.28	0.11	±0.18
9	Cempaka	3.15	±1.41	1.79	±0.69	8.09	±2.20
10	Isolation/Melati	2.50	±1.27	0.80	±0.38	6.59	±2.59
11	Flamboyan	2.18	±0.77	1.12	±0.49	7.79	±2.31
12	Seruni	2.00	±0.88	0.92	±0.33	5.18	±1.72
13	Tanjung	1.88	±0.82	1.44	±0.50	6.38	±2.66
14	Nusa Indah	1.97	±1.02	1.09	±0.54	4.24	±2.18
15	Maternity room	2.71	±1.78	1.65	±0.75	4.56	±1.98
16	Cendana II	3.62	±1.63	2.56	±0.97	9.76	±3.05
17	Café	-	-	-	-	-	-
19	Office	0.74	±0.83	1.03	±1.15	1.57	±2.23
20	IPS + Mosque	0.22	±0.34	0.18	±0.37	0.42	±0.83
21	Kitchen+Cleser	2.52	±4.96	0.82	±0.68	27.91	±7.34
22	CSSD	-	-	-	-	-	-
23	Laundry	0.24	±0.40	0.19	±0.35	0.41	±1.00
24	Cooperation	-	-	-	-	-	-
25	Sanitation	0.11	±0.27	0.09	±0.26	0.06	±0.24
26	Mortuary	-	-	-	-	-	-
27	Gardens	1.46	±1.94	0.73	±0.70	11.59	±5.52

FNAB : Fine Needle Aspiration Biopsy; UGD/IRD : emergency room; ICU : Intensive Care Unit; O.K : surgery room; RR : Recovery Room; IPS : maintenance facilities installation; CSSD : Central Sterile Supply Department.

3.2 Outdoor-environmental Comfort

Respondent's perception about the environmental comfort in relation to the sort of non-medical solid wastes can

be presented in Figure 1. Non-medical solid wastes in the Pare hospital has been sorted properly (53% of respondents) (Figure 1a). It is supported by the adequacy of availability of waste-basket and container (54% of respondents) (Figure 1b). 43% of the respondents argued that the sortation of non-medical solid wastes affect the amenities and environmental comfort (Figure 1c). According to Haqq (2009), a good wastes management is well responded by surrounding communities. As much as 62% of the respondents argued that the air temperature and relative humidity affect the comfort of the hospital environment (Figure 1d.)

3.3 Green Open Spaces (Park) in the Pare Hospital

Observations and estimation of tree shade zone indicate that the *Pterocarpus indicus* tree has a shading zone of 31,857.24 cm² (Table 2). These trees grow on the front-gardens of the hospital as a shading tree for visitors and their vehicles. These trees are planted in rows side by side with the king-palm (*Roystonea regia*) (Figure 1). The Pavilion Park and Cendana-II Park don't have shading tree, their vegetation are shrubs, herbs and grasses (Figure 2). Tree vegetation in the open green space has an ecological multifunction (Chiesura, 2004 and Saldivar et.al., 2004). This tree vegetation became the carbon stock and oxygen producer, as well as being able to improve the environmental comfort (Krisdianto, 2013). Therefore it is very important to provide the shading tree vegetation on the public service centers, such as in hospitals.

Table 2. Tree species in GOS of the Pare Hospital

No.	Location	Local Name of tree	Species	Σ Tree	Shading (m ²)	
1	Cempaka Park	“Beringin”	<i>Ficus benjamina</i>	1	1,960.72	
2	Pav Park	-	-	-	-	Scrubs, herbs and grasses
3	Front yard	‘Sono Kembang’	<i>Pterocarpus indicus</i>	14	31,857.24	
		‘Palem Raja’	<i>Roystonea regia</i>	10	12,036.82	
		‘Glodok Tiang’	<i>Polyalthea longifolia</i>	9	13,140.87	
4	Cendana II Park	-	-	-	-	Scrubs, herbs and grasses
5	ICU Park	‘Sawo Manila’	<i>Manilkara zapota</i>	4	493.78	



Figure 2 The front-yard (a) and ICU-park (b) of the Pare Hospital, Kediri

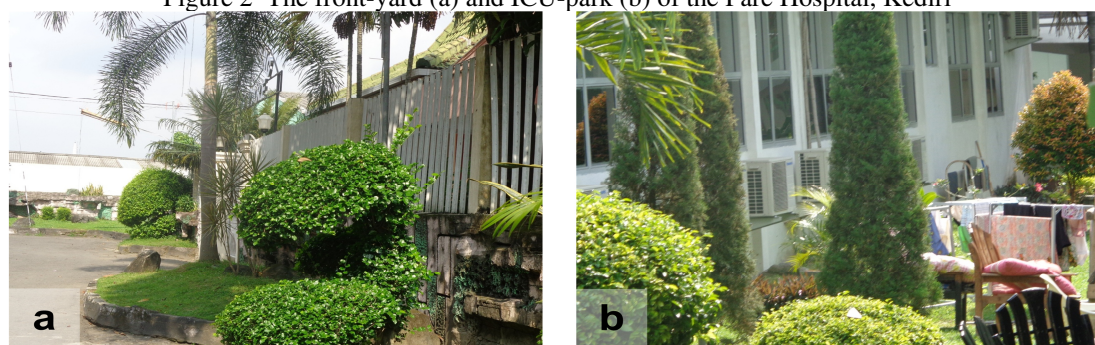


Figure 3. The Pav Park (a) and The Cendana-II Park (b) in the Pare Hospital

3.4 Thermal Discomfort Indexes

Daily air temperature at the Pare Hospital has a specific pattern. Air temperature at each location in the Pare Hospital is increased during the day and decline in the evening (table 3). Conversely, the relative humidity is high in the morning then decreasing during the day and increased in the evening (Table 4). According to Adi (2004), the air temperature and relative humidity also affect the incidence of nosokomial infections that occur in hospitals. Both of these climatic factors are correlated with the amount of bacteria in the air.

Air temperature and relative humidity influence the human life in terms of comfort and resistance against

thermal stress. According to Toronto Public Health Department (2013), the air temperature and relative humidity are two important factors that affect the personal comfort against effects of the weather, especially in the summer.

'Humidex' is an index which describes the thermal discomfort caused by temperature and relative humidity of air. This temperature-humidity index can be used to generate directives to minimize the danger of hot air based on normal human activities (Santee and Wallace, 2005). Results of the Humidex calculation shows that outdoor environment of the Pare Hospital suggest the thermal discomfort 'Very Strong' (Score = 41-46, Table 5). This suggests the need for sustainable wastes handlings and the management of green open spaces that can help decreasing the level of thermal discomfort.

Table 3. Air Temperature (°C) in GOS of the Pare Hospital

No.	GOS Location	Morning		Noon		Evening	
		mean	St.dev	mean	St.dev	mean	St.dev
1	Cempaka Park	31.03	±1.25	32.67	±1.18	30.43	±1.37
2	Cempaka Corridor	31.10	±1.17	32.67	±1.21	29.85	±2.31
3	Pav Park	30.91	±1.90	32.71	±0.96	30.34	±1.31
4	Pav Corridor	31.16	±1.18	32.64	±1.03	30.31	±1.25
5	Hospital yards	31.26	±1.10	32.84	±0.84	30.62	±1.37
6	Middle Doorlop	31.34	±1.13	33.37	±0.95	30.55	±1.36
7	Cendana II Park	31.26	±1.08	33.48	±1.01	30.48	±1.38
8	Cendana II Office	31.16	±1.12	33.54	±0.94	30.59	±1.48
9	ICU Park	31.04	±1.08	33.47	±0.81	30.59	±1.54
10	ICU Corridor	30.99	±1.19	33.36	±0.92	30.53	±1.51

Table 4. Relative humidity (%) in GOS of the Pare Hospital

No.	GOS Location	Morning		Noon		Evening	
		mean	St.dev	mean	St.dev	mean	St.dev
1.	Cempaka Park	70.90	±4.75	63.57	±4.41	69.05	±4.01
2.	Cempaka Corridor	70.67	±4.14	63.33	±4.45	69.19	±4.57
3.	Paviliun Park	70.17	±3.63	63.10	±4.66	69.05	±4.24
4.	Paviliun Corridor	70.29	±3.68	63.10	±5.05	68.57	±4.14
5.	Hospital Yards	70.03	±3.80	62.64	±4.31	68.10	±3.69
6.	Middle Doorlop	69.71	±3.89	60.52	±3.87	68.24	±4.36
7.	Cendana II Park	70.48	±3.79	60.19	±3.68	69.62	±3.84
8.	Cendana II office	70.40	±4.14	60.76	±3.82	68.95	±3.99
9.	ICU Park	69.40	±3.62	59.95	±4.07	68.52	±3.46
10.	ICU Corridor	69.52	±3.79	59.71	±3.39	68.76	±3.85

Table 5. Indexes of thermal discomfort (Humidex score) in the Pare Hospital

No.	GOS location	Humidex score during periode of:		
		Morning	Noon	Evening
1	Cempaka Park	43	46	41
2	Cempaka Corridor	43	46	41
3	Pav Park	43	46	41
4	Pav corridor	43	46	41
5	Hospital Yards	43	46	43
6	Middle Doorlop	43	44	43
7	Cendana II Park	43	44	41
8	Cendana II Offices	43	46	41
9	ICU Park	43	44	41
10	ICU corridor	43	44	41

Categories of *Humidex score*: No discomfort (score < 29); Slight discomfort sensation (30-34); Strong discomfort: limited heavy physical acts (35-39); very strong discomfort sensations (40-45); Harmful: it is recommended that you stop the activities (51-53); The dangers : heat stroke (score>54); (Eurometeo, 2013).

4. Conclusion

- The non-medical solid wastes such as plastics, paper and other organic materials, are widely produced in surgery room, and then followed by pavilion, impatient room and kitchen.

- The sorting of non-medical solid wastes in the Pare Hospital have been in accordance with the Green Hospital Principles, this sorting wastes have been carried out on a regular basis and are supported by the adequacy of wastes basket and wastes container.
- The green open spaces on the area of Pare Hospital have trees vegetation which is dominated by the *Pterocarpus indicus*, *Roystonea regia*, and *Polyalthea longifolia*.
- The thermal comfort level in Green Open Spaces of the Pare Hospital indicates the level of strong discomfort sensation to very-strong discomfort sensation.
- The tree vegetation in green open spaces of the Pare Hospital have not been able to create a thermal comfort environment, so it needs to be improved, particularly the amount and density of trees.

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