Application of Multipurpose Cadastre to Evaluate Energy Security of Land Parcel (Case Study: Gedung A and Gedung B, Institut Teknologi Sumatra)

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Key words: Multipurpose Cadastre, Energy Security, Land Parcel

SUMMARY

Energy security has one of its dimensions: Short-term energy security which focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance. Non-energy components (such as land parcel) that comprise an energy system are analyzed comprehensively with other component to measure energy security related to energy supply. Multipurpose cadastre which is an integrated land information system containing legal, physical, and cultural is used to evaluate energy (electrical energy) security of land parcel.

The fundamental component of multipurpose cadastre used to evaluate energy security is attribute data which is the value of land parcel facilities. Other fundamental components (geographic control data, base map data, cadastral data) are used as position information and provide weight in room (part of land parcel) valuation. High value-room means the room is comfortable and/or used productively by its occupant. The method of valuation is by comparing one facility to other facilities. Facilities included in room valuation are relatively static items (such as chair, desk, and cabinet) except lamps and other electronic devices. The room value and number of electronic devices which consume electrical energy are correlated with each other. Consumption of electrical energy of electronic devices in the room with average value remains constant while consumption in other room needs to be evaluated to save the energy.

The result of this research shows that room value correlate weakly with number of electronic device in corresponding room. It shows excess energy consumed in low- value room. Although numbers of electronic devices do not always mean the consumption of electrical energy and there are plenty electronic devices, it is recommended for occupant to be careful in utilizing electronic devices in low-value room to minimize energy consumption.

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1. INTRODUCTION

Energy security which is the uninterrupted availability of energy sources at an affordable price has one of its dimensions: Short-term energy security which focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance. Non-energy components (such as land parcel) that comprise an energy system are analysed comprehensively with other component to measure energy security related to energy supply. Multipurpose cadastre, which is an integrated land information system containing legal (e.g. property ownership or cadastre), physical (e.g. topography, man-made features), and cultural (e.g. land use, demographics), is used to evaluate energy (electrical energy) security of land parcel. Multipurpose cadastre is ideal solution as inputs as well as instrument in establish modern land administration system [1]. Multipurpose cadastre can be used as basic information and backbone for government policy [2].

The fundamental component of multipurpose cadastre used to evaluate energy security is attribute data which is the value of land parcel facilities. Other fundamental components geographic control data, base map data, cadastral data) are used as position information and provide weight in room (part of land parcel) valuation [3]. High value-room means the room is comfortable and/or used productively by its occupant. The case studies of this research are Gedung A and Gedung B that are located in land parcel owned by Institut Teknologi Sumatra in Lampung Province, Indonesia. The location of case study is shown on Figure 1. This research will show the method to evaluate excess energy consumption of room based on productivity and electronic devices.

2. METHOD

The process in giving value of facilities in room begins with collecting facilities data which related to attribute data and defining room boundary which related to spatial data. The process starts with data management and data processing. Tool used in applying multipurpose cadastre to evaluate energy security in this case energy consumption of land parcel is geographical information system (GIS). GIS The advent of computerised databases and GIS technology provides an opportunity to develop a greater understanding of land and how land may be more efficiently and effectively managed [4].

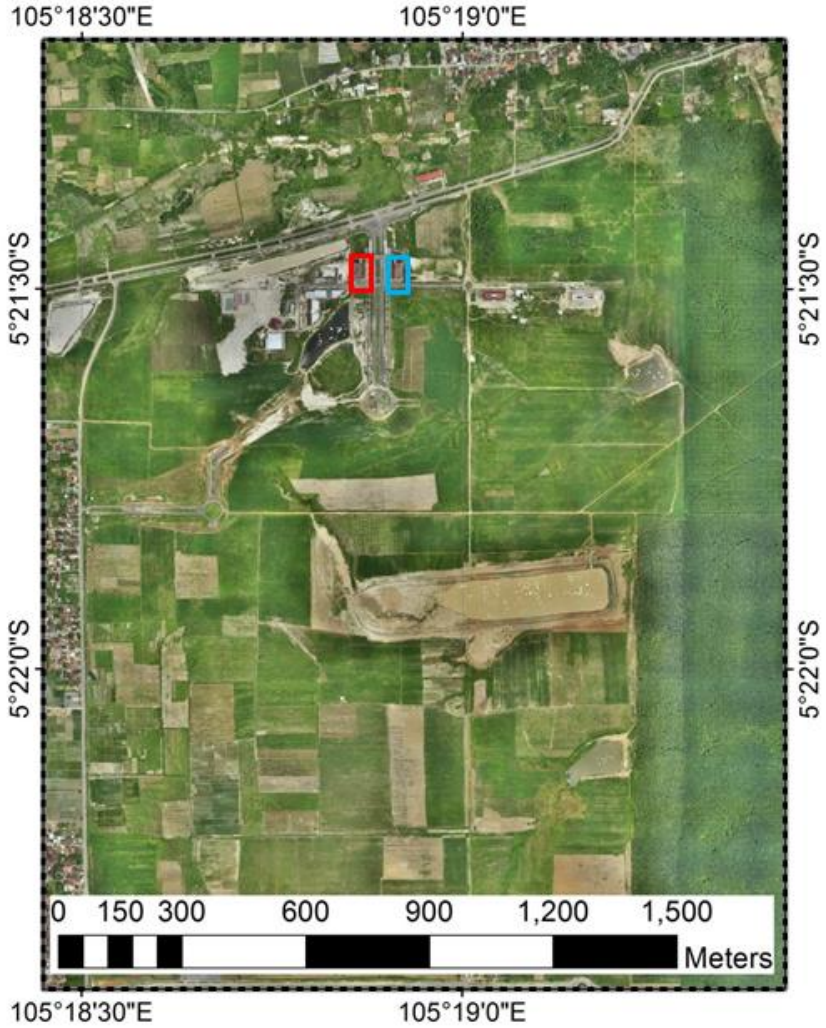

Figure 1. Location of case study. Gedung A is pointed by red rectangle while Gedung B is pointed by blue rectangle

2.1 Data Management Method

Data collected in applying multipurpose cadastre are the fundamental component of multipurpose cadastre. Those are spatial reference frame, base maps, cadastre map, attributes data. Spatial reference frame is collected from 13 bench marks located in Institut Teknologi Sumatera referred to geospatial reference frame SRGI2013, reference ellipsoid WGS84 and reference frame ITRF2008 epoch 2012.0. Current base map is obtained from photogrammetry measurement with scale 1:1000 acquired on February 2017. Cadastre map that delineate boundary of Institut Teknologi Sumatra parcel is obtained from Institut Teknologi Sumatera land document. The principal boundary of this research is delineation of boundaries of Gedung A and Gedung B which is obtained from Institut Teknologi Sumatera building floor

plan. Attributes data which is facility, occupant, and electronic devices are obtained by doing 'facility counting' activity.

Those attributes data are stored in database to facilitate updating, modifying, deleting the data. Those attributes data are classified into three entities: Facility, Room, and Facility-Room. Facility entity contains code, name, brand, figure, and category of facility. Category of facility is mark to distinguish whether the facility is electronic devices. Room entity contains code, name, usage, location, floor, and activity hour per day. Activity hour per day is mark to identify occupant activity in the room. Facility-Room entity contains facility code, room code which is constraint to code in facility entity and room entity, respectively, and number of good-conditioned facility, bad-conditioned facility, and unused facility in corresponding room. The code of facility and room are unique. Entity relationship diagram of this research is shown on Figure 2.

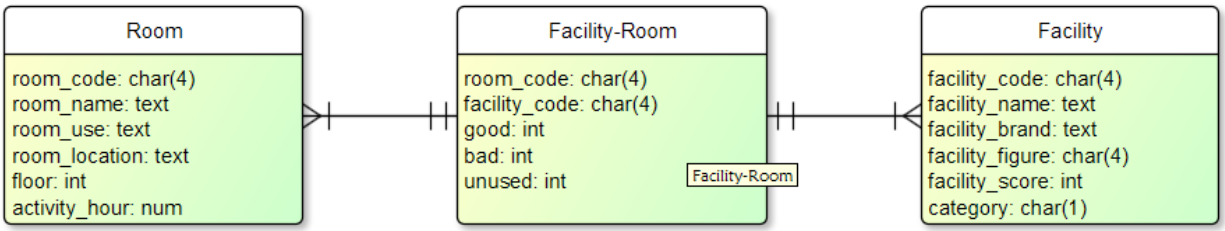

Figure 2. Entity relationship diagram of this research

The boundaries of Gedung A and Gedung B which is obtained from Institut Teknologi Sumatera building floor plan are rectified in Institut Teknologi Sumatera base maps with control points used are 4 corners of respective building. Area of room is calculated to provide weight in room valuation.

2.2 Data Processing Method

Exceed of energy consumption of every room are analysed by firstly calculate room value based on facilities beside electronic devices and electronic devices itself. Valuation and weighing for every facility is done depends on objective of valuation [5]. The objective of valuation in this research is to obtain energy consumption on respective room. It correlates with productivity of respective room. Less productive the room, it should be less energy consumed. Productivity of room can also be used to value a room [6]. Facility both electronic devices and general facilities valuation method is rating method based on its functionality.

The method of valuation is by comparing one facility to other facilities. General facilities included in room valuation are relatively static items (such as chair, desk, and cabinet) except lamps and other electronic devices. Electronic devices included in room valuation are air conditioner, CCTV, computer, dispenser, fan, lamps speaker, and other machines. The room value and number of electronic devices which consume electrical energy are correlated with

each other. Consumption of electrical energy of electronic devices in the room with average value remains constant while consumption in other room needs to be evaluated to save the energy.

3. DISCUSSION

The results of valuation are room values calculated both from general facilities and electronic devices. Differences in value for same room then are evaluated by comparing with other room value.

3.1 Room Value Analysis

Total room which is calculated in this research are 40 rooms in 2 buildings with 2 floors in respective building. Display of result is based on the location of room inside building and its floor resulting 4 displays: first floor of Gedung A, second floor of Gedung A, first floor of Gedung B, and second floor of Gedung B. Each display shows only either value calculated from general facilities or electronic devices. The value of room and its category is shown on Table 1. Displays of room value of first floor of Gedung A, second floor of Gedung A, first floor of Gedung B, and second floor of Gedung B are shown on Figure 3, Figure 4, Figure 5, and Figure 6.

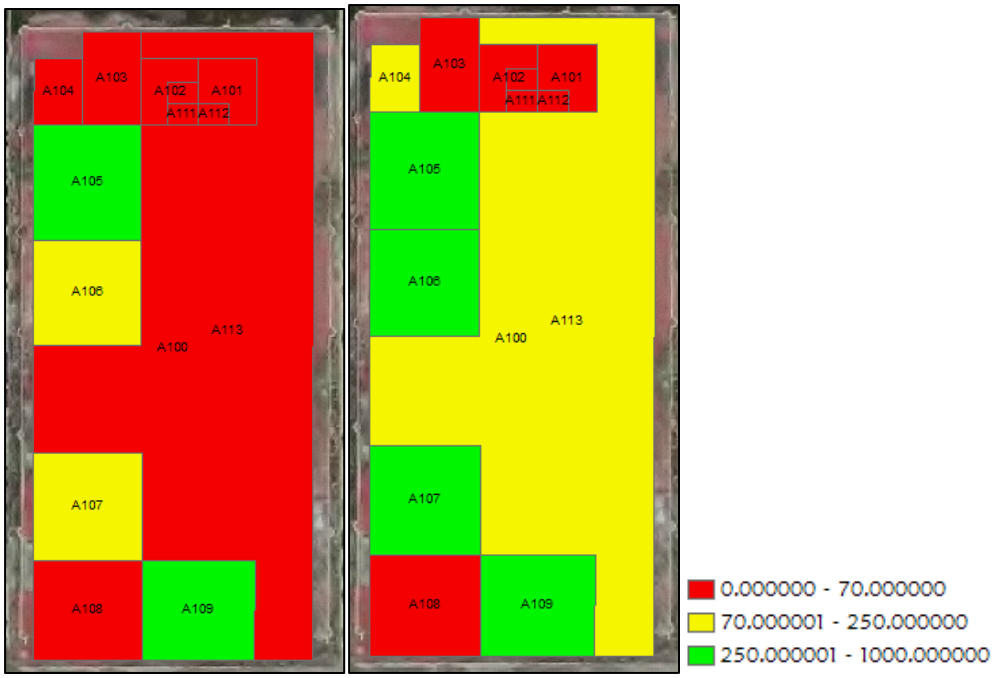

Figure 3. First floor of gedung A value calculated from general facilities (left) and electronic devices (right)

Table 1. Room value based on general facilities and electronic devices

Room Code	Room Name	Value based on general facilities	Category based on general facilities	Value based on electronic devices	Category based on electronic devices
A101	Toilet Pria	13.0	Low	7.8	Low
A102	Toilet Wanita	0.0	Low	9.4	Low
A103	Ruang Panel	4.9	Low	4.1	Low
A104	Gudang	48.4	Low	124.4	Medium
A105	A104	391.7	High	324.2	High
A106	A103	156.0	Medium	278.9	High
A107	A102	160.0	Medium	343.0	High
A108	Server	18.2	Low	39.3	Low
A109	A101	334.9	High	649.8	High
A110	Bilik Toilet Wanita	41.1	Low	0.0	Low
A111	Bilik Toilet Wanita	37.8	Low	0.0	Low
A112	Bilik Toilet Pria	39.6	Low	0.0	Low
A113	Koridor Gedung A	65.2	Low	86.4	Medium
A201	A206	99.5	Medium	36.9	Low
A202	A207	16.0	Low	16.6	Low
A203	A208	242.7	Medium	455.4	High
A204	A205	470.3	High	733.6	High
A205	A204	138.0	Medium	84.8	Medium
A206	A201	157.6	Medium	174.7	Medium
A207	A202	197.7	Medium	331.1	High
A208	A201	209.9	Medium	142.6	Medium
A209	Koridor Gedung A	12.0	Low	124.6	Medium

B101	Ruang Panel	3.7	Low	3.2	Low
B102	Toilet Wanita	44.0	Low	9.4	Low
B103	Toilet Pria	41.2	Low	2.2	Low
B104	B101	98.5	Medium	385.5	High
B105	B102	389.1	High	247.8	Medium
B106	B103	7.0	Low	54.1	Low
B107	B104	123.9	Medium	314.5	High
B108	B105	141.1	Medium	338.5	High
B109	Bilik Toilet Pria	69.0	Low	0.0	Low
B110	Bilik Toilet Wanita	36.9	Low	0.0	Low
B111	Bilik Toilet Wanita	40.5	Low	0.0	Low
B112	Koridor Gedung B	74.3	Medium	49.4	Low
B201	B202	149.6	Medium	151.8	Medium
B202	B201	130.5	Medium	207.6	Medium
B203	B203	65.6	Low	196.2	Medium
B204	B204	88.1	Medium	211.6	Medium
B205	B205	112.6	Medium	261.5	High
B206	Koridor Gedung B	170.0	Medium	411.9	High

Figure 4. Second floor of gedung A calculated from general facilities (left) and electronic devices (right)

Figure 5. First floor of gedung B calculated from general facilities (left) and electronic devices (right)

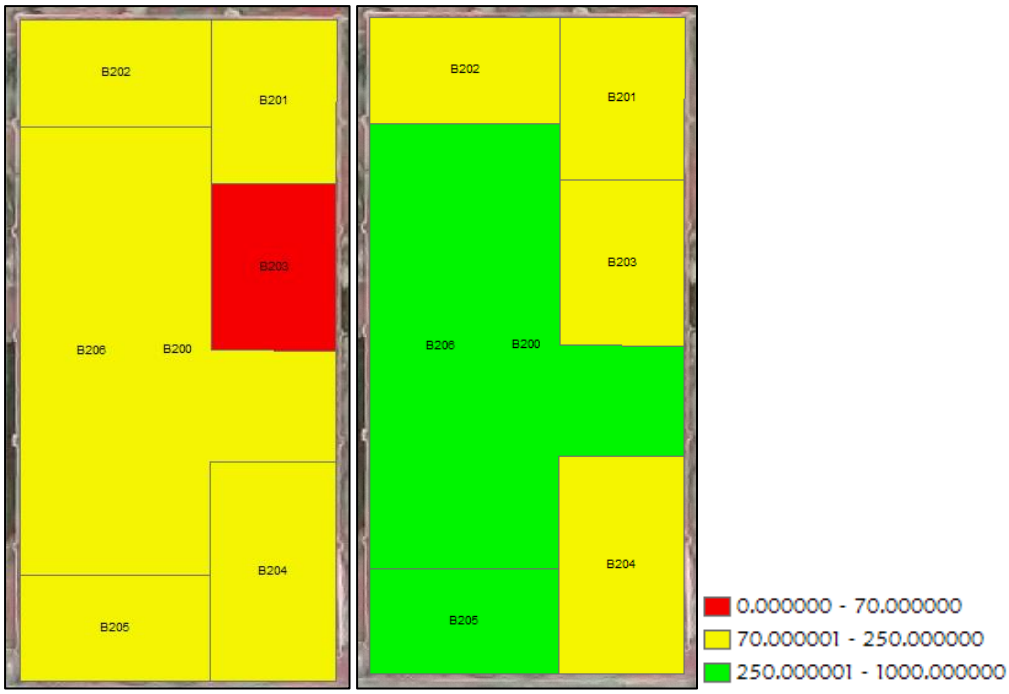

Figure 6. Second floor of gedung B calculated from general facilities (left) and electronic devices (right)

The classification of room value falls into three categories: high, medium, low for either facility based value or electronic devices based value. Based on those figures and category, room with excess energy can be identified such as room with yellow (medium) category in facility which becomes green (high) category in electronic devices. Each room falls into one category because of cumulative reason. Reasons are number of general facilities, number of electronic devices, occupant, and area of respective of room. For example, room B106 has low facility based value because of lack of facility and low activity hour. Room A204 has high facility based value because of considerably facility and high activity hour. Room B206 has high electronic devices based value because there are many electronic devices that possibly to consume much energy. Room B102 which is toilet room has low electronic devices based value because there are few electronic devices mean less energy consumption.

3.2 Energy Consumption

Consumption of electrical energy of electronic devices in the room with average value remains constant while consumption in other room needs to be evaluated to save the energy. It is identified by looking at facility based value. In this research facility based average value is 116.0 and electronic devices based value is 170.3. Simply, it means room with facility based value below 116.0 should have electronic devices based value below 170.3 to save energy. Excess of energy is calculated by subtracting difference of each room electronic based value

and average electronic based value with difference of each room facility value and average facility value.

The result of this research shows that room value correlate weakly with number of electronic device in corresponding room. It shows excess energy consumed in low value-room. Correlation between facility based value and electronic devices based value sorted by facility based value is shown on **Figure 7**. The category of excess energy in each room with excess energy is shown on **Table 2.** Room which is not shown on **Table 2** means energy used in corresponding room is secure.

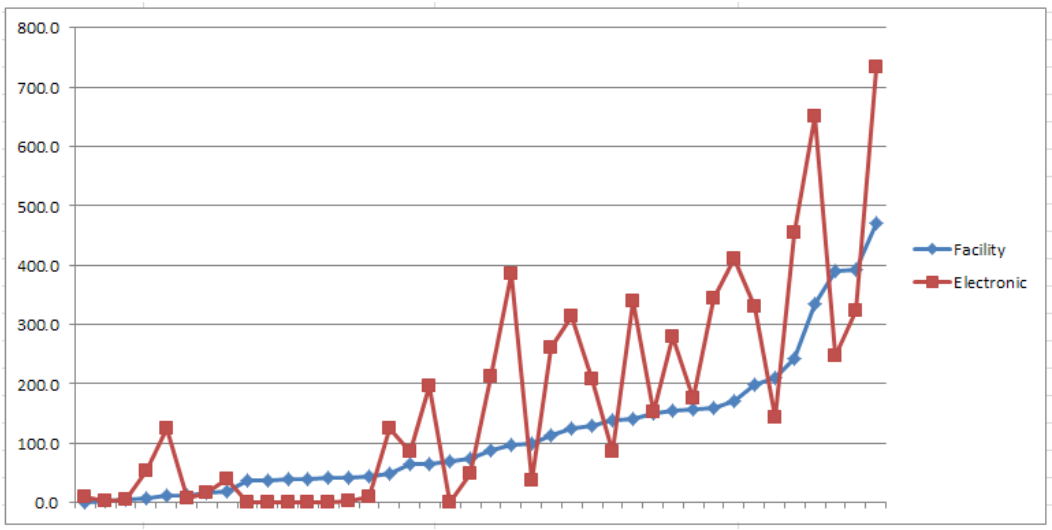

Figure 6. Correlation between facility based value and electronic devices based value

Table 2. Excess energy in room

Room Code	Value Difference	Category
A109	260.6	Critical
B104	232.7	Critical
A204	209.0	Critical
B206	187.6	High Need
A203	158.4	High Need

B108	143.1	High Need
B107	136.2	High Need
A107	128.7	High Need
B205	94.6	High Need
A207	79.1	Low Need
B203	76.2	Low Need
B204	69.2	Low Need
A106	68.6	Low Need
A209	58.3	Low Need
B202	22.8	Low Need
A104	21.7	Low Need

The classification of excess energy falls into three categories: critical, high need, and low need. Theoretically, there are some treatments to diminish excess energy of room. More critical the excess, more treatment needs to be done. Those treatments are:

1. Minimize energy consumption in the room. Although numbers of electronic devices do not always mean the consumption of electrical energy and there are plenty electronic devices, it is recommended for occupant to be careful in utilizing electronic devices in low-value room to minimize energy consumption.

2. Move electronic devices to other broader room. One of the factors in evaluating room value is room area. High electronic based value room often have many electronic devices with less facility because of not enough space in corresponding room.

3. Increase general facility in the room. If the room still have enough space to provide general facility, it will increase the productivity of corresponding room and make energy consumption more secure.

CONCLUSION

The method to evaluate excess energy consumption of room based on productivity and electronic devices produce classification of room with excess energy. The classification could lead to policy and strategies of energy security. The process started with concept of multipurpose cadastre: every land parcel has coordinates, boundary, and attribute data that show facility information and ends with evaluation of energy security. In this case study, there are 3 rooms with critical excess energy, 6 rooms with high excess energy, 7 rooms with low excess energy, and 24 rooms with secure energy. Although numbers of electronic devices do not always mean the consumption of electrical energy and there are plenty electronic devices, it is recommended for occupant to be careful in utilizing electronic devices in low-value room to minimize energy consumption.

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BIOGRAPHICAL NOTES

Satrio Muhammad Alif is born at Bandarlampung, July 8th 1995. He started bachelor degree in 2011 at and Geodesy and Geomatics Engineering in Institut Teknologi Bandung. He continued his master degree in 2015 at Geodesy and Geomatics Engineering. His research during his study belongs in geodynamics and GIS.

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