THE ANALYSIS OF VARIABLES WHICH INFLUENCE RENT-VALUE OF UNITS ON MULTI-LEVEL COMMERCIAL BUILDING BASED ON 3D NETWORK DATA STRUCTURE

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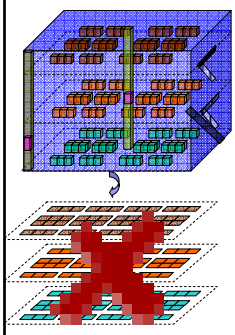
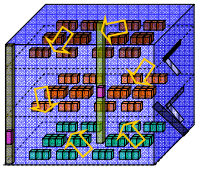
Representation of 3D unit Spatial Relation



- The limited supply of land, causes an inefficient horizontal commercial building to be built rather than the vertical one (**Multi-Level**).
- The fact, now can be seen by a lot of business units have been emerging in multi-stories building (**Multi-Unit**)

☑ The 3D objects presented as 2D projections in Geographic Information Systems (GIS) may loose some of their properties and spatial relationships to other objects (**Billen dan Zlatanova, 2003**)

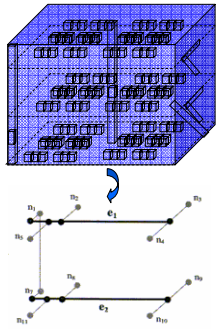
3D Spatial Relationship influences the unit value



- Value of sell/rent business unit per meter square on multi-level commercial building is not the same to unit which located in floor differ or different location although they was made from the same material.
- Vernor and Rabianski (1993) believe that value of business unit on multi-level commercial building influenced by the unit's location factor.

- ***Physical factor variable is easy to identify but location factor variable needs 3D spatial relationship analysis.***

3D Model for variable identification



- Yasin's research (2004) is to identify the location factors variable with spatial queries from wireframe 3D model of building units. *In fact, the identification of location variables are not fully based on the 3D model*
- 3D Network Data Structure is a correct data structure that makes an analysis of unit connectivity relationship for stories buildings become easy. (Lee,2001)
- 3D Network Data Structure can be used for analyzing the 3D spatial relationship of unit connectivity and identifying factors of unit location.

Problem Statement

- ***Problems***

1. Location and Physical unit factor variables are influence the value of selling and renting.
2. The ability of unit location factor variable identification depends on 3D spatial units relationship that currently used.

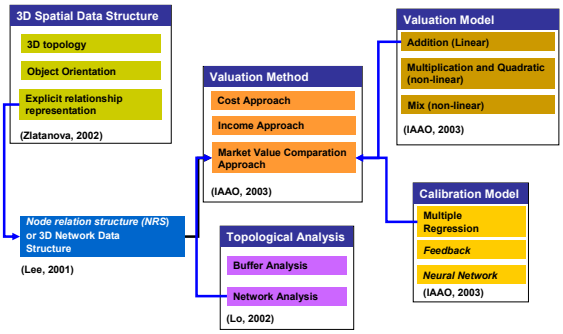
- ***Limitations :***

1. Location factor variables can be identified with data structure of 3D network.
2. Commercial property value predicted is commercial rent value
3. 3D spatial relationship unit model in commercial stories building is represented by 3D network data structure.

- ***Questions:***

1. How to build data structure of 3D network, which represents the topological relationships of units on multi-level commercial building?
2. What is the possible variable of location factor that influence the unit's of rent/sell value on multi-level commercial building?
3. How to identify the variable of location factor from 3D network data structure?

Concept



Research's Purpose and Benefit

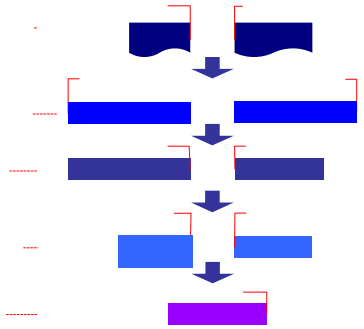
The Purposes :

1. Obtaining most influencing spatial relationship to rent-value units.
2. Obtaining model to predict rent value unit.
3. Obtaining spatial unit relationship for visualization in multi-level commercial building with 3D network data structure.

The Benefits

1. Besides giving an alternative technique in visualizing room units on multi-level commercial building data structure of 3D network also gives amenity and speed of identification of factor location.
2. Alternative of assessment method (comparative method) in assessment studies especially to assess business units on multi-level commercial building.

Research Method

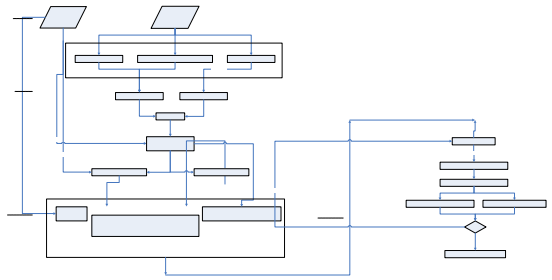


Hypothesis

ASUMPTIONS :

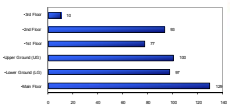
- **Units**
  - a. Space units, Escalator, Elevator : represented by node at the center of its polygon on the floor
  - b. Escalator : represented by node at start or end of its escalator polygon on the floor
  - c. Corridor : represented by node at the center of its corridor polygon
- **Variables**
  - Wide of unit (physical factor) has positively affected
  - Amount of access (physical factor) has positively affected
  - Floor level (location factor) has negatively affected
  - Closest Distance to Entrance (location factor) has negatively affected
  - Closest Distance to Elevator (location factor) has negatively affected
  - Closest Distance to Escalator (location factor) has negatively affected
  - Closest Distance to Stairway (location factor) has negatively affected to rent value of unit.
- *Reaching-distance* relationship among units has more influence to rent value rather than Reaching *time*.
- The Relationship of Rent-value and variables above are linear.

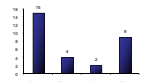
Research's Flowchart

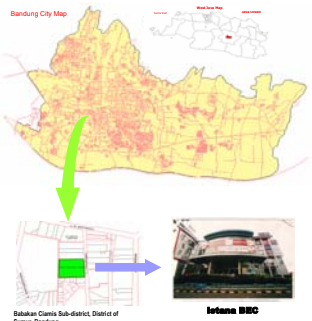


Research's Object

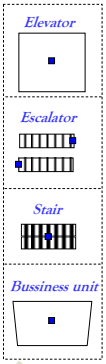
Research's object is the bussiness units in *Istana Bandung Electronic Center* (BEC) Building, Purnawarman street number 13-15 Bandung City.

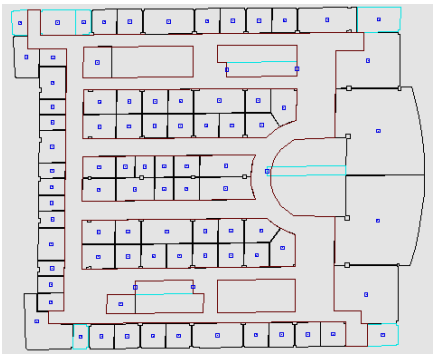




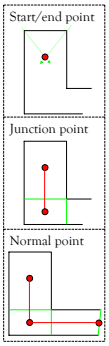


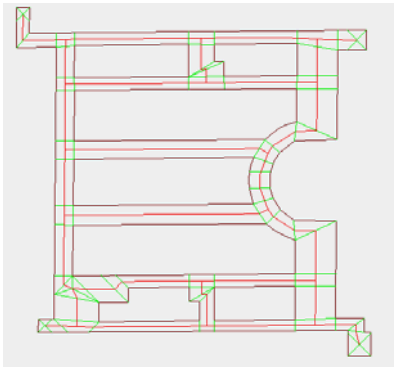
Unit Polygon Representation (*node*)



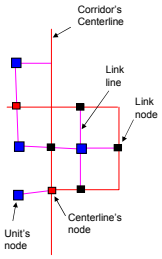


Corridor Polygon Representation(*center line*)

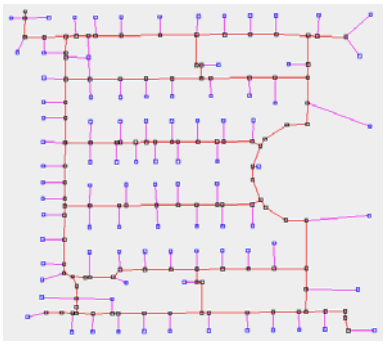




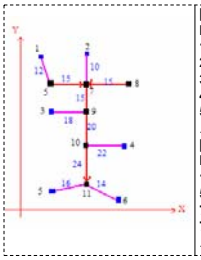
Linkage *node unit* to *corridor's* center line



Node Projection principle is centerline and if node projection +/- 0.5 m from centerline node then node unit linked to its centerline

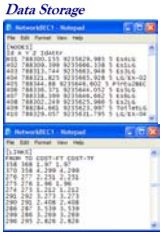


2D network data structure



[*Nodes*]
Id_Node, X, Y, Z, Attribute
1, 0.5, 4.8, 5, elevatorLt1
2, 3, 5, 5,Escalator 1st Floor
3, 1.5, 3,5,Stair 1st Floor
4, 3, 2, 5,Entry
5, 1, 0.7, 5,toilet
.....
[Topology]
From,**To**,Cost_FT, Cost_TF
1, **5**, 12, 12
5, **7**, 15,-1
7, **8**, -1, 15
7, **9**, 15, 15
.....

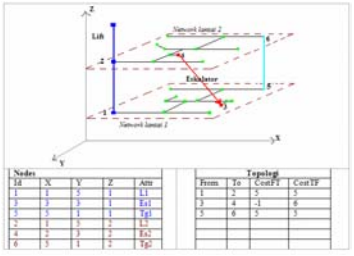
Data Storage



Each node has an identifier (Spatial ID), coordinate (X, Y, Z) and unit addresses information. Each connective line has a weight. The Weight relation between nodes is usually known as cost. The cost between nodes are not similar but depended its direction. After finishing all link of nodes to centerline corridor hence data structure of network 2D have been formed

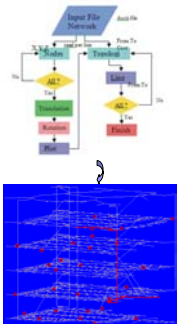
3D network data structure and visualization

3D Network Structure

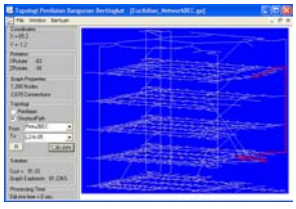


Data structure of network 3 dimension formed by link each pair of vertical conduit (elevator, escalator and stairway) nodes.

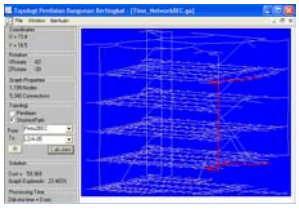
Algoritma visualization



Network Valuation and *shortest path*

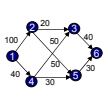


path analysis - shortest path **(entrance 2 BEC to L2/A-05)**



shortest path analysis – fastest path **(entrance 2 BEC to L2/A-05)**

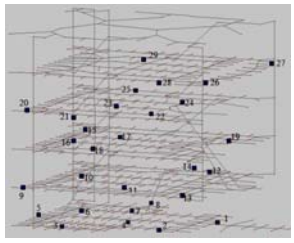
Shortest path **using djikstra algoritma**

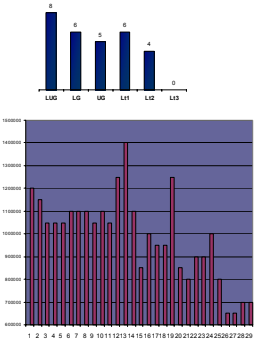


	1	2	3	4	5	6
1	0	100	∞	40	∞	∞
2	∞	0	20	∞	50	∞
3	∞	∞	0	∞	∞	40
4	∞	∞	50	0	∞	∞
5	∞	∞	∞	30	0	30
6	∞	∞	∞	∞	∞	0

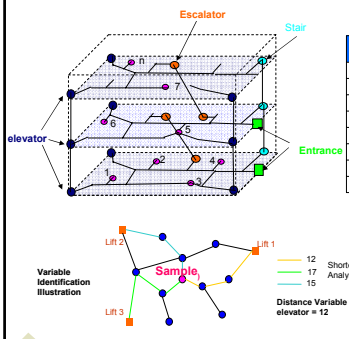
From	To	Shortest Path	Distance
1	2	1-2	100
1	3	1-4-3	90
1	4	1-4	40
1	5	1-4-5	70
1	6	1-4-5-6	100

Distribution data of Rental-unit sample



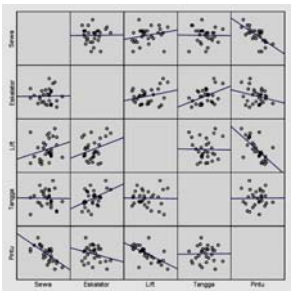


Variables identification using shortest path analysis

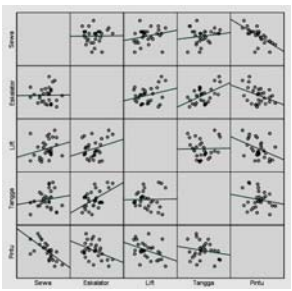


No.	escalator	elevator	Stair	entrance
1	45,68	57,69	79,415	25,834
2	43,803	47,542	99,579	44,887
3	24,628	24,705	72,669	71,333
4	51,53	51,607	75,872	46,467
5	26,164	26,241	59,269	73,125
6	32,329	24,135	45,86	74,307
7	8,95	20,96	42,685	67,986
..	..	..	..	..

Variable identified by network analysis

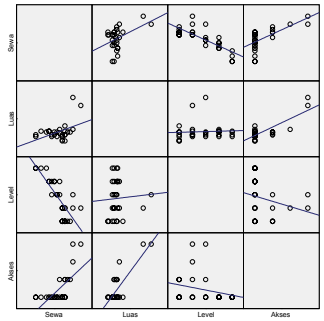


Linear relationships between unit's rent-value with location factor variables which has identified from euclidian-distance network



Linear relationships between unit's rent-value with location factor variables which has identified from time-distance network

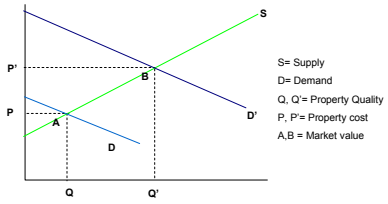
Variables without *network analysis*



Conceptual Model

Market Value Comparation Approach

- Property value can be estimated from the other value and property quality that known by an adjustment
- The changing of property quality will change the supply cost of its property then change the supply line.
- Property quality can be physical and location quality.



The Curve of demand canging of property type to the supply (Eckert, 1990)

Mathematical Model

Unit Value = f (physical character and location unit)

$$Rent\ value=b_0+b_1Size+b_2Level+b_3Access+b_4Entrance+b_5Elevator+b_6Escalator+b_7Stairway+e$$

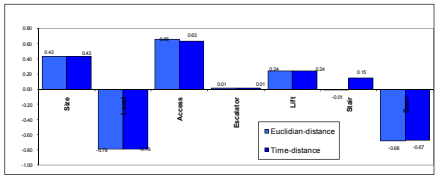
Rent variable as dependent variable and variables predictor: Size, Level, Access, Entrance, Elevator, Escalator, Stairway and Toilet as independent variables. *b0* is intercept value as rent value first-approach, assumed is equal to value rent if every predictor variables has zero value and *e* is error variable.

$$\Sigma e^2=minimum$$

Variable Correlation Analysis

Pearson Correlation between rent value and predictor variable

Correlation	Size	Level	Access	Escalator	Elevator	Stair	entrance
Reaching distance	0,43	-0,79	0,66	0,01	0,24	-0,01	-0,68
Reaching Time	0,43	-0,79	0,63	0,01	0,24	0,15	-0,67



Regression Model Analysis

Choosen Model

Model with higher *Adjusted R²* and lower std. Error of the estimate (*SEE*) will predict the better rent value

Euclid

Model Summary[j]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.794[a]	.631	.617	115679.833	.631	46.122	1	27	.000
2	.945[b]	.892	.884	63765.579	.262	63.168	1	26	.000
3	.970[c]	.941	.934	46150.606	.049	20.598	1	25	.000
4	.992[d]	.984	.981	25573.043	.043	64.630	1	24	.000
5	.994[e]	.988	.985	22773.182	.004	7.264	1	23	.013

a. Predictors: (Constant), Level
b. Predictors: (Constant), Level, Access
c. Predictors: (Constant), Level, Access, Door
d. Predictors: (Constant), Level, Access, Door, Escalator
e. Predictors: (Constant), Level, Access, Door, Escalator, Elevator
f. Dependent Variable: Rent

Time

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.794[a]	.631	.617	115679.834	.631	46.122	1	27	.000
2	.939[b]	.875	.865	68798.355	.244	50.621	1	26	.000
3	.952[c]	.906	.895	60821.653	.031	8.257	1	25	.008
4	.960[d]	.921	.908	56815.609	.015	4.650	1	24	.041
5	.973[e]	.946	.934	48705.647	.025	10.617	1	23	.003

a. Predictors: (Constant), Level
b. Predictors: (Constant), Level, Size
c. Predictors: (Constant), Level, Size, Door
d. Predictors: (Constant), Level, Size, Door, Escalator
e. Predictors: (Constant), Level, Size, Door, Escalator, Elevator
f. Dependent Variable: Rent

Empirical model and Regression Assumption Test

Choosen Coeficient Model

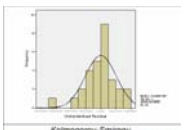
Coefficients[a]

Model		Unstandardized Coefficients: B	Unstandardized Coefficients: Std. Error	Standardized Coefficients: Beta	t	Sig.	Collinearity Statistics: Tolerance	Collinearity Statistics: VIF
	(Constant)	1480453.117	37714.902		39.256	.000		
	Level	-70646.427	3515.721	-.603	-22.370	.000	.726	1.377
	Access	71584.964	6088.610	.332	11.757	.000	.661	1.513
	Door	-4071.142	376.616	-.408	-10.810	.000	.373	2.683
	Escalator	-33944.032	396.549	-.213	-8.434	.000	.831	1.203
	Elevator	-1103.825	409.476	-.091	-2.695	.013	.581	1.721

a. Dependent Variable: Rent

Rent Value = 1.468.453 - 78646*Level* + 71585*Access* – 4071*entrance*- 3345*Escalator* – 1104*L*$_2$

Normal error distribution



Kolmogorov-Smirnov

	Statistic	df	Sig.
Unstandardized Residual	0,129	29	0,2

Shapiro-Wilk

	Statistic	df	Sig.
Unstandardized Residual	0,951	29	0,19

Ho=Error is not normally distributed
Ht=Error normally distributed
Significant Value >0.05 means Ho is rejected and Hi is accepted

Multicolinearity Test

	Collinearity Statistics: Tolerance	VIF
Level	0,726	1,373
Access	0,661	1,513
Door	0,373	2,683
Escalator	0,831	1,203
Elevator	0,581	1,721

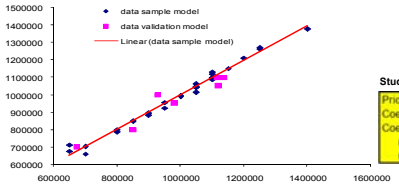
Multicollinearity happened when VIF>10, test result shows that VIF<10, so it can be concluded that there is no significant multicollinearity indication

Heterokedasticity Test

		Abs_Res
Rent	Correlation Coefficient	-0,223
	Sig. (2-tailed)	0,237
	N	29

This situation causes concern because the regression model will be unduly influenced by the high-value properties and thus be less reliable when applied to low value properties. Pearson's significance > 0.05, so it can be concluded that there is no significant heteroscedasticity of empirical model.

Model Validation

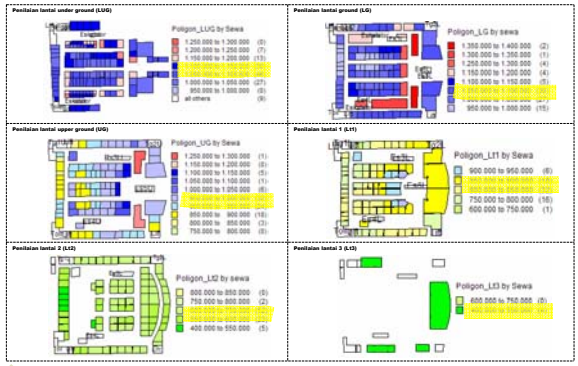


Study of Validation data Ratio:

Price Related Differential	0,999
Coefficient of Dispersion	0,037
Coefficient of Variation	
(%) Mean Centered	5,2
(%) Median Centered	5,5

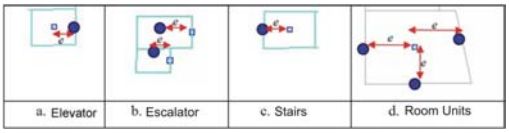
COV value at 5.2 % (*mean centered)* and 5.5% (median centered) **is tolerated by IAAO** (< 10 %). COD value at 0.037 **is tolerated by IAAO** (<20% for *income approach*). PRD value at 0,999 **is also tolerated by IAAO** (>0,98 dan <1,03)

Model Application

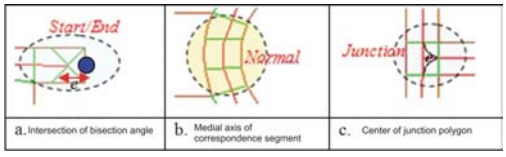


The Error Source in Variable Identification

- **The Assumption of Error for Unit Node Representation**

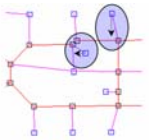


- **The Assumption of Error for Corridor Centerline**



The Error Source in Variable Identification

- **Aspect of line-projection of unit's node to corridor's centerline**



In this research, connective line of node to corridor is based on the projection of unit's node to corridor's centerline (dot projection to line) and if it has the distance of < 0.5m from the existing nodes of corridor's centerline hence unit node interfaced to proximate the exist node. The error of variable's coefficient, which is identified by network analysis, is affected by this assumption.

- **Aspect of dummy-height between floors**

a. This research assumes that the height of floor is equal for each floor in the building. It could be assumed as dummy-value, which is equal to 5 meters. This assumption will result incorrect geometric calculation on 3D network data structure as in reality the height of floor is different for each floor. However if in reality, the height between floors is same.
b. The error of height assumption will be not affect time-network because of the height relation of units are derived directly from the observation of the study object.

- **Aspect of network-weight**

The weight of network could be the source of error of variable identification both of euclidian-network and time-network weight. The weight of euclidian-network as source of error of variable identification depends on the accuracy of spatial data of the object while, the weight of time-network depends on the accuracy and consistency of time data from object

The variables which are influencing the rent-value

No.	Variable	*Euclidian network Correlation*		*Time network Correlation*	
		Sign direction	*Sig.*	*Sign direction*	*Sig.*
1	Size	?	No	Positive(+)	Yes
2	Level	Negative(-)	Yes	Negative(-)	Yes
3	Access	Positive (+)	Yes	Positive(+)	Yes
4	Entrance	Negative(-)	Yes	Negative(-)	Yes
5	Escalator	Negative(-)	Yes	Negative(-)	Yes
6	Elevator	Negative(-)	Yes	?	No
7	Stair	?	No	?	No

- There are variables that have same sign and significance from the model that are *level, access, entrance and escalator.*
- Variable of *size* and *stairway* are not significance to influence rent-value unit. Perhaps the data sample are not sufficient to be analyzed to get the significance of those variables or those variables are really not significance to influence rent-value unit.

Empirical Model Interpretation

rent-value = 1571675-78172***Level***+64703***Access*** – 5143***Entrance***-*3409****Escalator*** – *2046****Elevator***

From the empirical model, which formed can be interpreted as follows:

1.Intercept value is equal to + 1571.675, it means that the proximity of rent value at study object is equal to Rp **1.571.675/m²**.
2.The coefficient of variable of *floor-level* is equal to **-78172**, it means that an increase of 1 *floor-level* will decrease rent-value by Rp **78.172**.
3.The coefficient of variable of *mount-access* is equal to **+64073**, it means that an increase of 1 access will increase rent-value by Rp **64.073**.
4.The coefficient of variable of *escalator* is equal to **-3409**, it means that an increase of 1 meter *distance-to-escalator* will decrease rent-value by Rp **3409**.
5.The coefficient of variable of *entrance* is equal to **-2.046**, it means that an increase of 1 meter *distance-to-entrance* will decrease rent-value by Rp **2.046**.

Conclusion

1. Based on the results of identification of location factor variables, 3D network data structure has a potential to contribute in significant as a tool of rent-market-value assessment.
2. Based on the result of regression analysis of euclidian-network and time-network model, the primary variables which influence rent-value is:
   a. Mount of access: the coefficient has positively sign, which means an increase of access will be increase rent price.
   b. Floor-level: the coefficient has negatively sign, which means an increase of floor-level will be decrease rent price.
   c. Distance-to-escalator: the coefficient has negatively sign, which means an increase of the distance to escalator will be decrease rent-price.
   d. Distance-to-entrance: the coefficient has negatively sign, which means an increase of the distance to the entrance will be decrease rent-price.
3. The secondary variable is distance to elevator. Variable which has not influence significantly are size and stairway variables.
4. Based on the results of regression analysis of euclidian-network and time-network model, the spatial relationship among units that most influencing rent-value units, is Euclidian-distance.
5. Based on the results of ratio study of data validation, the appraisal's rents-value reflect rents market value.

Suggestion

The research has suggestions as follow:

1.It is important to intense this kind research, with same kind research's object and same kind research's method but with a large number samples to be more representing population.
2.The research only used one year observation, for the best result, it is important to extending time-period of sample rents unit observation particularly when markets are stable. Even when prices are changing, the technique can be effective if rent prices are adjusted for time.
3.To minimizing the error of the coefficient of location factor variables on network, it is important to analyze geometric network potential error number for each variable identification coefficient.
4.It is important to study other variables, which are probably influence rent value units on multi-level commercial building.

THANK YOU