Problem in application carrying capacity approach for land allocation assessment in Indonesian municipal spatial planning: A case of Kutai Kartanegara Regency

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Abstract. Urbanization in many countries, such as Indonesia, is commonly appeared as a dynamic population of developed areas. It is followed with reducing rural uses of land for improving urban land uses such as housing, industry, infrastructure, etc. in response to the growth of population. One may not be sufficiently considered by the urban planners and the decision makers, urbanization also means escalation of natural resources consumption that should be supported by the natural capacity of the area. In this situation, balancing approach as carrying capacity calculation in spatial planning is needed for sustainability. Indonesian Spatial Planning Law 26/2007 has already expressed about the balance approach in the system. Moreover, it strictly regulates the assessment and the permission system in controlling land development, especially for the conversion. However, the reductions over the rural uses of land, especially agriculture, are continuously occurred. Concerning the planning approach, this paper aims to disclose common insufficiency of carrying capacity considerations in Indonesian spatial planning practice. This paper describes common calculation weaknesses in projecting area for the urban development by recalculating the actual gap between supply and demand of agriculture land areas. Here, municipal spatial plan of Kutai Kartanegara Regency is utilized as single sample case to discuss. As the result, the recalculation shows that: 1) there are serious deficit status of agriculture land areas in order to fulfil the demanded agriculture production for the existed population, 2) some calculation of agriculture production may be miss-interpreted because of insufficient explanation toward the productivity of each agriculture commodity.

1. Introduction

In term of the sustainability, dynamic population of urban area escalates forces for expanding agricultural land use to accommodate basic need of the population [1], [2], [3], [4]. Dynamic population means escalation of natural resources consumption that needs to be supported by the area. Meanwhile, for many developing countries, urbanization is still interpreted as a circumstance where rural use of land must be converted into housing, industry, infrastructure, public facilities, etc. It is followed by insufficient consideration toward balance system between the population and the capacity of the developed areas [5], [6]. By the above circumstance, the balance system is a crucial idea to be considered by the urban planners and the decision makers.

In case of Indonesia, rapid urbanization has brought consequences as shrinking agricultural areas in many municipalities. In fact, each year, 6% agriculture areas are converted into non-agricultural areas [7], especially in Java Island. Desolately, this situation is continuously happened by the designed land

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use of spatial planning. Beside strictly regulates land the assessment and the permission of land utilization, Indonesian Spatial Planning Law 26/2007, conceptually, has already expressed the balancing consideration in the system. It is defined as carrying capacity (CC) [8]. For this concern, Spatial Planning Law 26/2007 is not the only law. There is Environmental Protection and Management 32/2009 (Law 32/2009) that obligates spatial plan assessment toward CC of the area [9].

However, the system implementation becomes practically uncertain in municipal level. It has been a fact that decentralization of spatial planning in Indonesia escalated the problems [10]. It brings skepticism toward the practiced planning process in municipalities. Concerning to the land use plan, many argue that the uncertainty is caused by uncertainty of the system and the implementation [11], [12], [13], [14]. Among them, one interesting argumentation is the improper calculation in allocating land use corresponds to supply and demand balance between the natural capacity and the population [7].

Regarding the scepticism, this paper concerns about the problem in defining land utilization in Municipal Spatial Plan. This paper aim is disclose common insufficient consideration toward spatial CC in Indonesian spatial planning practice, particularly the supporting capacity. CC in Indonesian spatial planning and land use allocation has been discussed by some disciplines especially toward the importance and the administration, such as [1], [15], [16]. For the resulted gap between the practical calculation and the plan is still rarely done. Therefore, this paper takes this issue as the focus of discussion.

Since Law 32/2009 doesn't define specific method of balance land use allocation, this paper utilizes equations of agriculture production supply and demand defined by Ministerial Regulation of Environment 17/2009 (Permen LH 17/2009) for projecting the required areas of agriculture land [17]. As individual sample case, one of Municipal General Spatial Plan (RTRW) is evaluated. Here, Municipal General Spatial Plan of Kutai Kartanegara Regency 2016-2036 (RTRW Kutai Kartanegara) is the best sample case to study. Comparing to other Indonesian municipalities, Kutai Kartanegara is one of richest municipalities by the natural resources with level of poverty is relatively high. Moreover, it is one of Indonesian municipalities that shows large area of land conversion.

2. Literature Review

According to Miller, CC is maximum number of population can be supported by the natural resources and environment in a region, to support well-being without a significantly depleting or degrading it resources [18]. In accordance, ecologically, CC is interpreted as capacity of environment with the natural resources to support the inhabitant without any threat over the sustainability [19]. It is also about balance among communities and the capacity of the environment [20]. By Law 32/2009 CC is divided into supportive capacity (SC) and assimila¬tive carrying capacity (AC) [9]. SC means the capacity of the environment to support the lives of the people and other living organisms. AC is the capacity of the environment to absorb matters, energy and/or other components that come into the environment, ei¬ther by them or through human intervention. Concerning to the CC concept, the objective of spatial planning is to enhance the area´s compat¬ibility, harmony and balance with its sub-system [21]. By Permen LH 17/2009 one approaching indicator for practical supporting capacity may be built based upon supply and demand calculation of agricultural land in response to the dynamic consumption of the population [17].

3. Methods

This paper evaluates area of land for agriculture that is defined by RTRW Kutai Kartanegara 2016-2036. The evaluation is conducted as recalculation of the existed supply and demand of agricultural land area in response to the existed population. Here, the equation of supply and demand defined by Permen LH 17/2009 is utilized. By the calculation, the gap between supply and demand is identified. Here, the gap reflects the amount areas of agriculture land must be provided for the development. Then, it may compare to the existed land area defined by the plan. Principally, the calculation uses basic assumption that rice production reflects the supporting capacity of the planned area. Since the agriculture is not merely rice, the calculation required conversion of all agriculture products into rice product, that are all Agriculture Product stated by Municipal Statistic Bureau in 2015 [22]. In the calculation, money value

of each agriculture products is converted into rice money value. This conversion is conducted in order to draw the same value for further converted into amount area of land.

In order to build the discussion, this paper is built into some sections. First is introduction, it describes the current situation that leads to the necessity of research's discussion. Second part gives some previous theoretical discussion that supports the perspective toward land use conversion, carrying capacity, and the basic calculation. The second part also contains with result of calculation and the discussion related to the defined land use plan of RTRW Kutai Kartanegara. Finally, this paper builds full conclusion based upon the discussion. It also points some findings that may give opportunity to be observed further and developed as a specific discussion

4. Result and Discussion

4.1. Overview of Municipal Development

Kutai Kartanegara Municipality is located in Eastern part of Kalimantan (Borneo) Island. It is one municipality under East Kalimantan (Borneo) Province administration. Kutai Kartanegara Municipality has land area of 27.263.10 km2 and water area of 4,097 km2. This municipality is divided into 18 Kecamatan (district). Similar to other Indonesian municipalities, most of population are reside in each district centre, especially district of Tenggarong. Between 2010-2014, the population increase by rate of 4,64% per year. It is categorized mid-high comparing to other municipalities in East Kalimantan Province. Four main dominant sectors by their contribution for local income are mining (83,84%), agriculture, farming, forest, and fisheries (6,34%), building (3,21%), trading, hotels & restaurant (2,86%) (KLHS Kutai 2016). However, the biggest contributor is still on Oil and Gas. By Indonesia decentralization, Kutai Kartanegara faces the boost economy development and becomes one Indonesian municipality with biggest contribution to national economy development.

In 2016, the municipal government revised the RTRW by some new development agendas of new plan of harbour development, growing trend of palm oil plantation [23]. Some local characteristics are influencing the new plan. In social-economy statistic, Kutai Kartanegara faces large number of population growth, jobless population and improper people settlements. Regarding the geological circumstance, turf and swamps dominate the area. It is one constraint in allocating land for development. In environmental issue, this municipality faces problem of water and soil pollution caused by mining and domestic activities [24]. Moreover, current housing development is spread over the municipal areas [23]. It becomes a constraint for urban infrastructure development.

4.2. Demonstrated CC Calculation for the New RTRW

Some basic data are utilized in re-calculating the SC of the planned area. One is population data. Second is land allocation. The third data consists with various agricultural production data that are taken from the Municipal Statistic Bureau in 2015 [22]. This data is useful in determining the area of agriculture. In line with the examined data in the process of RTRW revision, population and land allocation data for this research are taken from municipal basic data by year of 2014.

Commonly, the population are concentrated in centre area of development. For Kutai Kertanegara, the concentration is existed in Tenggarong Disctrict. Table 1 shows the distribution of municipal's population by year of 2014. From the table, the less concentrated area of population is Muara Wis.

Table 1. Population Growth of Kutai Kartanegara Municipality

No	Name of District	2010	2011	2012	2013	2014
1	Samboja	54.515	56.619	58.347	60.107	61.387
2	Muara Jawa	33.923	35.562	36.988	38.455	39.932
3	Sanga-Sanga	17.588	18.276	18.834	19.404	19.965
4	Loa Janan	56.071	57.785	59.087	60.394	61.647
5	Loa Kulu	39.938	41.136	42.040	42.945	43.183
6	Muara Muntai	17.315	17.515	17.570	17.623	17.645

No	Name of District	2010	2011	2012	2013	2014
7	Muara Wis	8.557	8.702	8.772	8.841	8.894
8	Kota Bangun	31.292	31.913	32.286	32.653	32.978
9	Tenggarong	96.209	100.323	103.801	107.363	110.090
10	Sebulu	36.420	37.070	37.433	37.786	38.090
11	Tenggarong Seberang	61.441	63.762	65.656	67.585	69.477
12	Anggana	32.688	34.432	35.979	37.586	39.210
13	Muara Badak	39.834	41.271	42.424	43.595	44.734
14	Marang Kayu	23.394	23.697	23.807	23.913	23.984
15	Muara Kaman	33.909	34.615	35.055	35.489	35.876
16	Kenohan	9.861	9.905	9.950	9.994	10.038
17	Kembang Janggut	23.817	25.634	27.371	29.217	31.145
18	Tabang	9.908	9.998	10.089	10.541	10.274
	Jumlah	626.680	648.215	665.489	683.131	700.439

Source: Kabupaten Kutai Kartanegara Dalam Angka, 2015

Table 2. Land Use Allocation

No	Land Use	Area (Ha)				
		2010	2011	2012	2013	2014
A.	Conservation Area					
1	Conservation forest	212.614	212.614	212.614	212.614	210.097
2	Natural Preservation	20.556	20.556	20.556	104.177	104.177
3	National Forest	50.726	50.726	50.726	50.726	40.974
4	National Park	67.766	61.776	61.776	61.776	61.776
	Total	351.662	345.672	345.672	429.293	412.024
B	Cultivation Area					
1	Forestry:					
	Permanent Production (HP) (incld. mangrove)	787.675	787.675	787.675	787.675	760.799
	Limited Production (HPT)	504.294	504.294	504.294	504.294	542.413
	Total	1.291.969	1.291.969	1.291.969	1.291.969	1.303.212
2	Non-Forestry					
	Agriculture	46.286	38.300	31.182	38.069	32.563
	Plantation	44.747	51.179	54.797	54.832	56.686
	Mining	378.655	378.655	533,74	533,74	533,74
	Settlement	19.591	20.808	21.470	22.105	22.252
	Industry					
	Fisheries	67.776	61.776	61.776	61.776	61.776

Source: Kabupaten Kutai Kartanegara Dalam Angka, 2015

For land allocation, Table 2 shows the existed situation in 2014. It shows land use Cultivation Area of Forestry dominates the allocation. Meanwhile the non-Forestry that refers to urban activities and settlement is the lowest. However, this situation doesn't reflect the real capacity that is potentially developed further. Practically, the situation faces wide area may not cultivated by the geological, geographical, and other physical factors of the land. Here, Table 3 shows the land allocation based upon the geological, geographical, and other physical factors of the land. It is developed based upon the GIS areas calculation upon the registered 2014 existing land use map of Fig.1. The resulted area is quite different to Table 2 because the basic method of calculation is different. From this point forward, this paper uses Table 3 as the actual land condition in order to compare with the result of supply-demand

calculation based upon the population and agriculture productions. Particularly, the utilized data of Table 3 are: Plantation, Wet and Dry Agriculture Area.

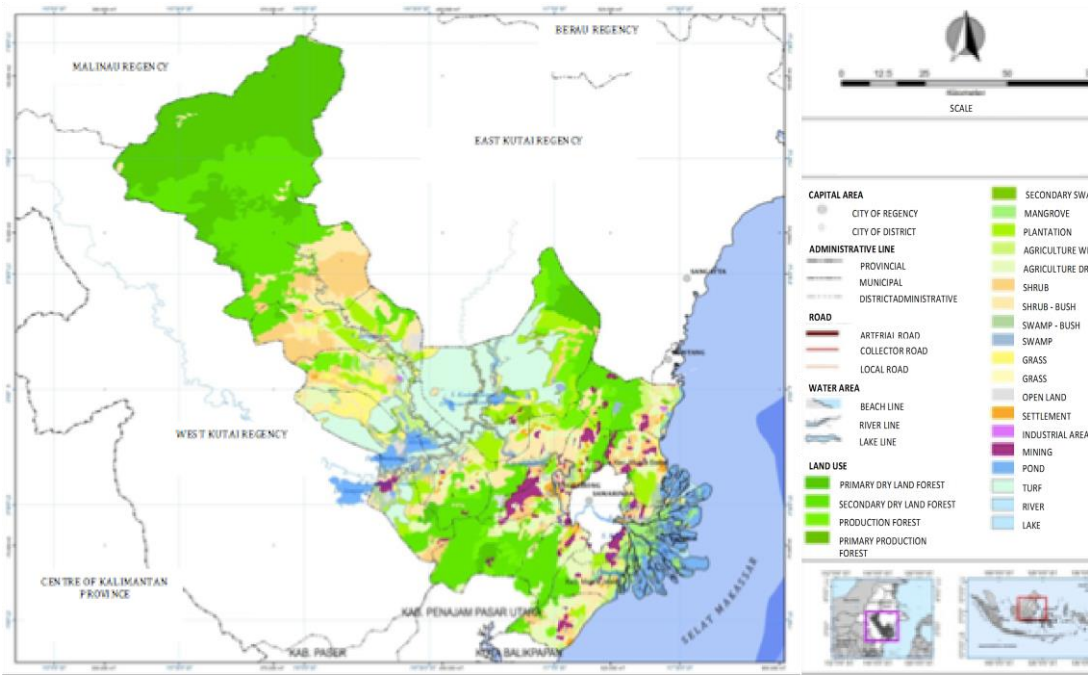


Figure 1. Land use map
Source: RTRW Kutai Kartanegara 2016

Table 3. Land Allocation in 2014

No	Land Allocation (based upon spatial data 2014)	Area (ha)
1	Sailing	139.448
2	Grove	183104.899
3	Mangrove	39568.844
4	Dry Forest	1065887.720
5	Swamp (Forest)	92049.722
6	Production Forest	104663.164
7	Industrial Area	934.449
8	Plantation	181502.022
9	Settlement	19922.664
10	Open Land	25051.184
11	Wet Land Agriculture	42984.6228
12	Dry Land Agriculture	17401.88617
13	Swamp	47847.220
14	Bush	418640.889
15	Grass-land	99459.289
Source: GIS calculation over RTRW 2016 map		

By conducting supply and demand approach for agriculture production, the required area for agriculture may be predicted in response to the population growth. Specifically, the calculation is done by the following formula. Then, table 4 shows the result of calculation for each district.

$$\text{SL} = \frac{\sum(P1\ x\ H1)}{Hb} X \frac{1}{Ptvb} \quad (1)$$

$$\text{Ptvb} = \frac{Pb}{Lb}$$

Where:

SL : Agriculture Land Supply (Ha)
P1 : Production of each agricultural commodity
H1 : Money value of each commodity (rupiah)
Hb : Rice money value
Ptvb : Rice productivity
Pb : Rice Production
Lb : Padi field area

Table 4. Calculated Supply Area for Agriculture

No	District	∑P1 x H1	Hb	Pb (Kg)	Lb (Ha)	Ptvb (Kg/Ha)	SL (Ha)
1	Samboja	Rp. 725.212.824.951	Rp. 9.375	14.333.000	2.888	4.963	15.586,70
2	Muara Jawa	Rp. 618.158.556.000	Rp. 9.375	1.636.000	432	3.787	17.411,21
3	Sanga-Sanga	Rp. 19.124.478.376	Rp. 9.375	289.000	74	3.905	522,34
4	Loa Janan	Rp.308.723.042.714	Rp. 9.375	4.332.000	887	4.884	6.742,69
5	Loa Kulu	Rp. 387.101.039.650	Rp. 9.375	33.162.000	6.507	5.096	8.102,02
6	Muara Muntai	Rp. 118.145.312.800	Rp. 9.375	3.064.000	733	4.180	3.014,81
7	Muara Wis	Rp. 19.025.393.389	Rp. 9.375	1.031.000	239	4.314	470,44
8	Kota Bangun	Rp. 282.619.182.742	Rp. 9.375	12.232.000	2.407	5.082	5.932,11
9	Tenggarong	Rp. 225.714.307.545	Rp. 9.375	17.963.000	3.278	5.480	4.393,57
10	Sebulu	Rp.234.491.164.233	Rp. 9.375	15.044.000	3.141	4.790	5.222,28
11	Tenggarong Seberang	Rp. 446.703.892.074	Rp. 9.375	40.009.000	7.601	5.264	9.052,35
12	Anggana	Rp. 123.705.143.252	Rp. 9.375	8.288.000	1.861	4.454	2.962,87
13	Muara Badak	Rp. 110.393.460.104	Rp. 9.375	1.687.000	378	4.463	2.638,45
14	Marang Kayu	Rp. 498.723.990.885	Rp. 9.375	14.937.000	2.949	5.065	10.502,69
15	Muara Kanan	Rp. 277.266.327.374	Rp. 9.375	17.603.000	3.725	4.726	6.258,43

Table 4. Calculated Supply Area for Agriculture

No	District	∑P1 x H1	Hb	Pb (Kg)	Lb (Ha)	Ptvb (Kg/Ha)	SL (Ha)
16	Kenohan	Rp. 60.926.332.604	Rp. 9.375	1.182.000	284	4.162	1.561,47
17	Kembang Janggut	Rp. 87.405.067.320	Rp. 9.375	2.010.000	588	3.418	2.727,39
18	Tabang	Rp. 93.719.918.021	Rp. 9.375	5.700.000	1.707	3.339	2.993,78
Total		Rp. 5.180.100.524.735	Rp. 9.375	194.502.000	39.679	4.902	106.095,60

Using similar assumption, demand on agriculture land reflects the supporting capacity should be provided as the consequences of dynamic population. The utilized equation in defining demand of agriculture land is depicted as the following. Table 5 shows the result of the calculation.

$$\mathrm{DL} = Nx\ KHLL \tag{2}$$

$$\mathrm{KHLL} = \frac{1\ Ton}{Ptvb}$$

DL : Agriculture Land Demand (Ha)
N : Population
Ptvb : Rice productivity
KHLL : Each person's demanded area for adequate living condition (converted into rice consumption rate per person)

Table 5. Calculated Demand of Agriculture Land

No	**District**	**Population**	**Ptvb (Kg/Ha)**	**KHLL (Ha)**	**DL (Ha)**
1	Samboja	61.837	4.963	0,201	12.459,73
2	Muara Jawa	39.932	3.787	0,264	10.544,39
3	Sanga-Sanga	19.965	3.905	0,256	5.112,15
4	Loa Janan	61.647	4.884	0,205	12.622,55
5	Loa Kulu	43.813	5.096	0,196	8.596,92
6	Muara Muntai	17.645	4.180	0,239	4.221,21
7	Muara Wis	8.894	4.314	0,232	2.061,75
8	Kota Bangun	32.978	5.082	0,197	6.489,38
9	Tenggarong	110.900	5.480	0,182	20.237,72
10	Sebulu	38.090	4.790	0,209	7.952,72
11	Tenggarong Seberang	69.477	5.264	0,190	13.199,40
12	Anggana	39.210	4.454	0,225	8.804,27
13	Muara Badak	44.734	4.463	0,224	10.023,39
14	Marang Kayu	23.984	5.065	0,197	4.735,14
15	Muara Kanan	35.876	4.726	0,212	7.591,78
16	Kenohan	10.038	4.162	0,240	2.411,84
17	Kembang Janggut	31.145	3.418	0,293	9.111,07
18	Tabang	10.274	3.339	0,299	3.076,79
Total		**700.439**	**4.902**	**0,204**	**149.252,20**

Further, comparison between the calculations results the surplus or deficit status of the area. In this case, it is articulated as each district's status. Table 6 shows the distribution of status. It shows most of district in Kutai Kartanegara are in deficit status of agriculture land, especially in Sanga Sanga that the demanded agriculture area over than 10 times from the available supply area.

Table 6. Allocation Status After Supply-Demand Comparison

No	District	SL (Ha)	DL (Ha)	Comparison	Status
1	Samboja	15.586,70	12.459,73	SL > DL	Surplus
2	Muara Jawa	17.411,21	10.544,39	SL > DL	Surplus
3	Sanga-Sanga	522,34	5.112,15	SL < DL	Deficit
4	Loa Janan	6.742,69	12.622,55	SL < DL	Deficit
5	Loa Kulu	8.102,02	8.596,92	SL < DL	Deficit
6	Muara Muntai	3.014,81	4.2221,21	SL < DL	Deficit
7	Muara Wis	470,44	2.061.75	SL < DL	Deficit
8	Kota Bangun	5.932,11	6.489,38	SL < DL	Deficit
9	Tenggarong	4.393,57	20.237,72	SL < DL	Deficit
10	Sebulu	5.222,28	7.952,72	SL < DL	Deficit
11	Tenggarong Seberang	9.052,35	13.199,40	SL < DL	Deficit
12	Anggana	2.962,87	8.804,27	SL < DL	Deficit
13	Muara Badak	2.638,45	10.023,39	SL < DL	Deficit
14	Marang Kayu	10.502,69	4.735,14	SL > DL	Surplus
15	Muara Kanan	6.258,43	7.591,78	SL < DL	Deficit
16	Kenohan	1.561,47	2.411,84	SL < DL	Deficit
17	Kembang Janggut	2.727,39	9.111,07	SL < DL	Deficit
18	Tabang	2.993,78	3.076,79	SL < DL	Deficit
Jumlah		**106.095,60**	**149.252,20**	**SL < DL**	Deficit

4.3. Evaluation over the New Plan

Table 4 shows different result of agriculture supply land areas to the data of agriculture land allocation showed by Table 3. This situation is possible occurred by the different utilization basic data. Table 3 is calculated based upon the physical characteristic of land meanwhile the Table 4 is calculated based upon the conversion of agriculture production data into the land area. However, the identified gap may insignificant to be considered further instead of the comparison with the resulted deficit areas.

By comparing total area of agriculture land of Table 3 to the resulted deficit area of Table 6, there are wide gap of land supply indicated. Table 3 represents the current area of agriculture land and the other maximum potential area may be converted to agriculture land. Wide gap between these two tables indicates serious problem of land allocation defined by new spatial plan. In this sense, the land use plan is designed under high insufficient SC of the planned area. In other words, the new spatial plan has already suffered overcapacity in responds to the dynamic population.

Concerning the planning process under law 26/2007, common practiced CC consideration is conducted merely by projecting the population growth in order to be accommodated into housing land allocation. In this case, the housing land use is allocated based upon land classification analysis. This analysis doesn't have any calculation toward the capacity of the land in providing the natural resources for the population. Theoretically, it determines the land capacity based upon the geographical and geological characteristic. Unfortunately, this analysis doesn't have restriction in order to conserve the potential land for agriculture. Then, the housing (urbanization) land uses are continuously provided without further consideration toward the CC.

5. Conclusion

Based upon the discussion, some concluding remarks are identified that spatial planning process of RTRW Kutai Kartanegara is suffering overcapacity of the natural resources. The unpleasant new plan situation is caused by insufficient consideration about CC, especially the supporting capacity. Particularly, the above discussion leads to some important points that are:

1. Insufficient consideration results uncertain land use allocation corresponds to the agricultural production capability of the area in supporting the dynamic population.
2. Insufficient consideration is indicated by unavailable certain data of agriculture development that are integrated to the spatial analysis for land use allocation.
3. Gap between the calculated land supply for agriculture and the existed data used in practical planning process indicates less compatibility of agriculture land supply-demand approach to the spatial analysis for land use allocation.
4. The incompatibility may caused by money valuation and unidentified harvesting frequency of each agriculture product in order to be converted into area of rice production land. Further, these factors may be clarified and the equation may be improved

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