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Research Article

Non-adherence to the residential private open space to building footprint coverage regulations in Lagos state: a research-evidenced need for introspection

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Residential private open spaces are instrumental to the creation of pleasant residential environments, contributing to the individual character, identity, and appearance of the residential area. Therefore, the problem of inadequate percentage of the residential private open spaces prevents the urban residential environment from attaining city sustainability. This problem is rooted in the non-adherence to building regulation standards especially in cities in Nigeria. In metropolitan Lagos, a study of three selected medium density residential estates reveals a non-adherence to the building regulation for the private open space to building footprint coverage ratios in the residential estates. The research method used in this study is methodological triangulation employing both quantitative and qualitative methods. The sampling is based on multistage cluster sampling, and the data collection tools were high resolution satellite imagery, survey (through the administration of questionnaires). The results of the study reveal that in the medium density residential estates, a typical spatial pattern of the residential private open spaces from imagery classification data and ground truth data have ratios that indicate 70% of the Residential lot is for building footprint coverage while 30% is reserved for private open space as opposed to the specification by the Lagos state building regulation which specifies that 60% should be reserved for building footprint coverage and 40% for private open space. In conclusion, it is imperative that there be an introspection and a possible review of the Lagos state building regulation in the face of 21st century realities of the Lagos metropolitan population demands.

Keywords: residential private open spaces, non-adherence, building footprint coverage, building regulations

1 Introduction

The growth of cities in developing countries into healthy and safe cities is predicated upon their development guidelines and regulations and adherence or compliance to it. These include urban planning regulations at a city scale and building regulations at a landscape scale. These laws and regulations are purposely designed to regulate various development aspects that includes, zoning practices, private open space (POS) to building footprint coverage (BFC) ratios, greenspace to greyspace ratios, occupancy type building height and so on based on the peculiar needs of each city. The problem of rapid and unplanned rate of urban growth in Lagos state is a threat to its sustainable development. This unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution, and environmental degradation and loss of Urban open spaces. It also encourages the non-adherence to the building regulations which were designed to provide ecosystem services, psychosocial services and health services to the residents of the city. Although residential areas have been researched upon, research from a landscape architecture perspective that enquires into the availability and role of private open spaces in residential areas is sparse in sub-Saharan Africa. In consequence, the results of this research will reveal information as well as inspire new thinking about residential private open spaces and the non- adherence to specified blueprints of the Lagos state building regulation. A summary of the aspects of the Lagos state building regulations that concern residential private open spaces are described in the Table 1.

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Table 1 Lagos state building regulation (spatial patterns summarized)

Use zone (residential density type)	Plot size (m^2)	Maximum building footprint coverage per plot (%)	Dwelling units per hectare (no)	Greenspace landscaping percentage per plot (%)
Low	1,000	50	30	20
Medium	864	60	90	10
High	648	70	270	10

Source: Lagos State Building Regulation. 2010. https://epp.lagosstate.gov.ng/regulations/REVISED_LASPPPA_REGULATION_2019_1.pdf

Table 2 Summary of LASG building regulation for spatial structure

Residential density	Private open space to building fooprint coverage (POS : BFC) Lagos State Government building regulation
Low density	50POS:50BFC
Medium density	40POS:60BFC
High density	30POS:70BFC

Greenspace: Greyspace (GRN: GRY) Ratio calculation in the Private Open Space.

Greenspace Permitted for Low Density: 20% Of the Residential Lot.

Private Open Space Permitted for Low Density: 50% Of the Residential Lot.(50POS:50BFC)

So Greenspace Takes 20/50 = 40 GRN: 60 GRY

Private Open Space Permitted for Medium Density: 40% Of the Residential Lot.(40POS:60BFC)

Green Space for Medium Density = 10/40 = 30 GRN: 70 GRY.

Private Open Space Permitted for Medium Density: 30% Of the Residential Lot.(30POS:70BFC)

Greenspace for High Density = 10/30 = 30GRN: 70 GRY.

A summary of the Lagos state building regulation spatial structure is hence described below in Table 2.

1.1 Adherence to building regulations in different cities of the world

Contemporary Building regulations address several issues from building layout to the building material standards and even the height of the building. Paris is one of the Cities where building regulations for Private open space to Building footprint coverage have been adhered to and the consequent positive impact has earned the city its status as one of the world's greatest capital worthies of emulation to many. This was achieved through the provision and strict adherence of land use regulations dated back to 1867 during the second empire. It is worthy of note that prior to this period, the city of Paris was famous for being the European capital of dirtiness and filth because of its sporadic growth and its characteristic network of narrow roads and streets, inadequate or absence of open spaces (Pasold, 2012). The George-Eugene Haussmann's sustainable planning philosophy brought an immense impact on the provision of building regulations that includes appropriate private open space to building footprint coverage ratios, meant to ensure safety, better lighting, and a healthy built environment and this led to the shift of Paris in the 19th century from dirtiest city to beautiful and healthy city. The city of Stockholm which is the capital city of Sweden is another example of planned city par excellence in Europe. Despite suffering eight fire outbreaks within a century, the primitive impetus to have a planned city ensured that the rebuilding of the city was planned in an orderly manner under the City Planner known as the" Conductor." As early as 1640, the Master Plan of the area, was adopted and land use regulations that made provision for adequate private open space to building footprint ratios that allow for firefighting machines as well as outdoor recreation, lighting and ventilation has improved the quality of the built environment and thereby making the city to what it is today (Pasold, 2012).

As a general guide in Australia according to (Australian Capital Territory (ACT), 2013), private open space should have a minimum area equal to half (50%) the total residential lot to which it relates (It is sometimes 60%). In other words, the acceptable Private open space to Building footprint coverage ratio for residential areas with single dwelling unit is 50 POS:50BFC (or 60POS:40BFC in some cases.) In other words, the acceptable Private open space to Building coverage footprint ratio for residential areas with single dwelling unit is 50POS:50BFC (or 60POS:40BFC in some cases.)

In the U.S.A. Building regulation began in the late 1800s when major cities began to adopt and enforce building

codes in response to large fires in densely populated urban areas. The scope of early building codes has broadened from the primary intent of reducing fire risk and have become sets of regulations that address structural integrity, fire resistance, safe exits, lighting, ventilation, and construction materials, private open space to building footprint coverage ratio and so on. They specify the minimum requirements to safeguard the health, safety, and general welfare of building occupants. The adherence level is high and several states have strict penalties to non-adherence. The International Code Council (ICC) publishes 15 models codes which are updated every three years through an open, consensus based process (ICC, 2021). The development and widespread adoption of building codes has created a uniform regulatory environment in which design professionals and contractors are held to a set of standards adopted by and applicable to the jurisdiction in which they work (ICC, 2015). Different states in the United States of America have differing residential open green space standards. However, the average percentage to be devoted to landscaping amounts to a minimum 15% of total lot area in residential developments, and 10% of the total lot area in non-residential developments, although they can be as much as 25% in some states. Also, the ratio of organic landscape materials (Greenspace) to inorganic landscape materials (grey space) is specified at an average of 70% to 30%. In the Hollywood Vehicular Use Area and Landscaping Regulation, Vehicular use areas of more than 15.24 m are to set aside 25% of the entire area for green space, while lots of less than 15.24 m are to set aside 15% of the entire lot for green space (Hollywood Community Redevelopment Agency (Hollywood CRA, 2007)).

In Japan, where earthquakes are far more common than they are in the United States, the building regulations are even more strict. After the Kobe earthquake in 1995, which killed about 6,000 people and injured 26,000, Japan has made a great endeavour to put enormous resources into new research on protecting structures, as well as retrofitting the country's older and more vulnerable structures. In Japan, depending on the Land Use Zone category the Building Coverage Ratio is regulated within 30% to 80%, and a building has to be constructed within the specified maximum Building Footprint Coverage Ratio in the zone (Ministry of Land, Infrastructure and Transport (MITT) Japan, 2013)

1.2 Adherence to building regulations in Nigerian cities

The history of Land use regulation in Nigeria is traced to the pre-colonial era when land was allocated and controlled by the traditional rulers. Oduwaye (2006a) stated that land-use administration in Nigeria was vested in natural rulers or community heads in different part of the community, prior to colonial administration or before 1854 (Oduwaye, 2006b). The traditional rulers are called Obas in the West, Emirs in the North and Obis in the Eastern part of Nigeria. They had the power to allocate, re-allocate and supervise land use. In 1946 the promulgation of Nigeria Town and Country Planning Ordinance made Provision for the planning improvement and development of different parts of the country. The post Nigerian independence period was a time when regional governments in Nigeria retained the 1946 Town and Country Planning Ordinance, however several states developed their own planning regulations, a good example of which is Lagos state that had its bye law in 1981 named "Lagos State Town and Country Planning Law", this bye law was adopted by other states of the federation. This Lagos state building regulation has guided development of building in several sections of Lagos such as Victoria Island, Apapa, and several planned part of Lagos, and has been revised periodically to reflect the needs of the rapidly growing metropolitan city and to improve the health and imageability of Lagos city (Oko, 2010). However, there is the problem of non-adherence to building regulation standards especially in cities in Nigeria which has also been observed in literature. Raji and Attah (2017) explored the level of non-adherence of building setbacks, and its resultant effects in Suleja, Niger State, Nigeria. Their research results identified several problems arising from non-compliance to building setbacks regulations, which includes, lack of outdoor spaces for parking vehicles and unsafe environment which they submitted all leads to a poor city growth. Onwuanyi and Ndinwa (2017) elucidated that in their research on residential areas in Benin city, Edo State, Nigeria, several landlords were seen to disregard the green (private open space) to built-up (building footprint coverage) area of their plot of land as specified by law and they built up almost every inch of their plot of land. This has also greatly impacted on the residential outdoor space (private open space) left for the residences (Onwuanyi & Ndinwa, 2017). Aluko (2011) highlighted the problems associated with development control as well as the level of compliance to building regulation space standards in Lagos metropolis, Nigeria based on the (Lagos State Urban and Regional Planning Development Law, 2010). He stated that the problem of development control in Lagos state is reflected in the non-compliance with the stipulated regulations for building development in the state and that these problems arise from a gradual deviation from master plan of Lagos and deregulatory authorities on development through distortion, alteration, and deviation from planning standards.

The main violators include both the public and private sectors aided by the inefficiency and indiscipline of regulatory officials as well as the compromises made by government agents in charge of development control. He enumerated that among the common contraventions are the encroachment on public rights of way and open spaces, the spring-up of buildings under high-tension lines with their roofs a few metres below the lines, the take-over of building set-backs by front shops. Also, the construction of buildings in violation of building approvals, General violation of Urban and Regional Planning Laws in Lagos State, corruption by enforcement officers and Construction of properties on public utility setback (Aluko, 2011).

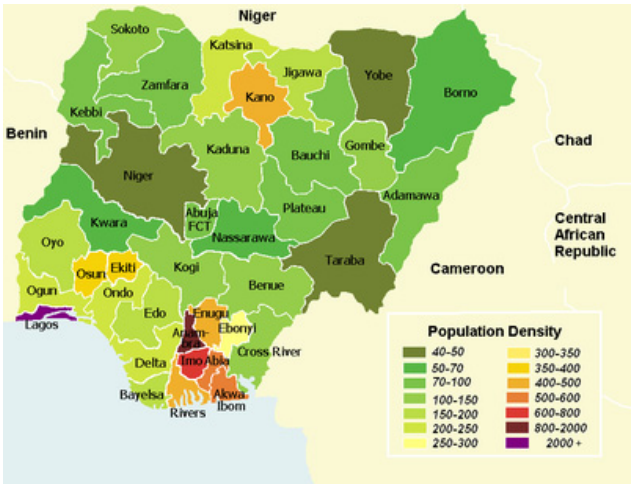


Figure 1 Map of Nigeria
Source: www.lagoslink.com

2 Materials and methods

2.1 Study area

Lagos was created in 1967 and served as the capital of Nigeria till 1991. It is located in the South-Western part of Nigeria. It has a coverage area of 3,350 sqkm. In terms of spatial development or growth, Lagos originated as a traditional settlement of close to 3.85 sqkm in about 1881 and has grown to over 1,183 sqkm in recent times. Expansion of Lagos was due to the growth of the colonial economy (Agbola & Agunbiade, 2009). Lagos State served as the seat of government between 1914 and 1992. In 1992, the Federal capital was moved to Abuja but that did not change the fact that Lagos has a more vibrant economy than Abuja due to its possession of the largest seaport and the most useful railway terminus. It is also a prominent seat of export and import out of and into the country. In the very heart of the state, lies the Lagos metropolis and it has the Atlantic seaboard as the southern boundary. It stretches 30 km long with its broad southern base along the Bight of Benin and it tapers northward and terminates at Agege at about 26 km. It is framed by longitudes 2° 42′ E and 3° 22′ E of the Greenwich Meridian and latitudes 6° 22′ N and 6° 42′ N of the equator. The metropolitan area comprises of sixteen out of the twenty Local Government Councils which make up the State. They include: Lagos Island, Eti-Osa, Lagos Mainland, Surulere, Ikeja, Ajeromilfelodun, Amuwo-Odofin, Alimosho, Apapa, Ojo, Somolu, Kosofe, Mushin, Oshodi-Isolo, Kosofe, Agege. Lagos metropolitan area is a low lying littoral body, with about 175 sqkm of built-up area of which residential areas occupy the single



Figure 2 Map of Lagos State
Source: www.lagoslink.com

largest proportion of 89.39 km^2 (51.9%), commercial 8.21 km^2 (4.8%), industrial, 14.44 km^2 (8.4%) institutional and special use 23.66 km^2 (13.7%), open spaces 4.53 km^2 (2.6%) and transportation 32.05 km^2 (18.6%) (Oduwaye, 2005). The metropolitan Lagos according to literature constitutes about 34% of the state. This accounted for close to 455 km^2 of the metropolis (Oduwaye, 2005). As a result of the fact that Lagos is the commercial nerve centre of the nation, there is an observable trend of migration into the city of Lagos. However, apart from being the smallest city in regard to landmass, and according to Lagos state statistics, the state accommodates or has the highest population (over 17.5 million) in the country and is regarded as the second fastest growing city in Africa. The residential areas are classified according to residential densities. The residential estates selected in this research fall under the medium density residential areas. The map of Nigeria, and map of Lagos state are shown in the Figs 1–2.

2.2 Research methods

The research methodology for this study is a methodological triangulation (also known as mixed methodology). Guba (1981) suggests that it is proper to select that paradigm whose assumptions are best met by phenomenon being investigated. Methodological Triangulation arose from an ethical need to confirm the validity of the processes and it can be achieved by using multiple sources of data (Yin, 2003). It is also used to compare data to decide if it corroborates (Creswell, 2003; Patton, 2002), and thus, to validate research results. The research philosophically leans towards postpositivistism and its focus on experimental and quantitative methods have been complemented to some extent by an interest in using qualitative methods to gather broader information outside of readily measured variables (Gephart,1999). The research design framework usually stems from the nature of the research problem and the mode of inquiry seeks to answer the research questions. This therefore influenced the choice of methodological triangulation this research and hence the Quantitative and Qualitative modes of inquiry adopted in tackling the research questions. The quantitative methods to reveal the existing private open space to building footprint coverage utilized survey data collection methods through the administration of questionnaires, however, qualitative methods utilized the high-resolution, object-oriented satellite imagery and provided complementary data which was analyzed, and this validated and complemented the data acquired through the quantitative methods.

Table 3 Summary of LGAS, LCDAS and their residential densities

Administrative division (admin-div)	No of L.G.As (admin-div) under Metropolitan Lagos	No of L.G.AS randomly selected in admin-div	L.G.As selected	L.C.D.AS subdivisions in Selected Lgas	No of L.C.D.As purposively selected	No of residential estates purposively selected	Residential densities
IKEJA	8	1	KOSOFE	3 1. Ikosi-Isheri 2. Kosofe 3. Agboyi-Ketu	1 Kosofe	1 Atunrase Estate	medium density
BADAGRY	3	1	AMUWO-ODOFIN	2 1. Oriade 2. Amuwo-odofin	1 Amuwo-odofin	2 Apple Estate Raji Rasaki Estate	medium density

Source: Fadera

Table 4 Name of residential estates and number of building units

Type of estate	Name of estate	Total number of building units. (sampling frame)	Sample size (questionnaire) confidence level 95% confidence interval 5	Number of questionnaires, administered	Number of questionnaires, returned
Public	Raji Rasaki, Amuwo	142	104	100	70
Private	Atunrase, Gbagada	105	83	85	64
Private	Apple Estate, Amuwo	95	76	80	64

Source: Fadera

Table 5 Residential estates and number of questionnaires administered

Estate name	Number of questionnaires returned	Percentage of return (%)
Private estate (Apple Estate)	64	80
Public estate (Raji Rasaki Estate)	70	70
Private estate (Atunrase Estate)	64	75
Total	198	Avg: 75

Source: Fadera

Table 6 Imagery data information

6 images fit your filter criteria					Catalogue							Digital globe
Select	Browse image	Catalog id	Imaging bands	Space craft	Acquisition date	Total max off nadir angle (o)	Area max off nadir angle (o)	Area min sun elevation	Area max GSD (m)	Total cloud cover pct (%)	Area cloud cover pct (%)	MS Aggr
	view	10400100170D2A00	Pan-MS1-MS2	WW03	2016/01/25	22.0	22.0	57.64	0.35	0	0	N/A
	view	104001001A504500	Pan-MS1-MS2	WW03	2016/04/10	20.8	20.8	73.50	0.35	4	4	N/A
	view	103001004E6E5500	Pan-MS1-MS2	WW02	2015/12/08	26.7	26.7	55.18	0.57	0	0	N/A
	view	104001001CD61C00	Pan-MS1-MS2	WW03	2016/04/29	16.3	16.3	72.54	0.33	0	0	N/A
	view	1040010029D6CD00	Pan-MS1-MS2	WW03	2017/02/14	24.6	24.6	60.20	0.36	35	35	N/A
	view	10500100047B4C00	Pan-MS1	GE01	2016/05/21	18.4	18.4	63.90	0.45	3	3	N/A

Source: Digital globe foundation, 2017

Three residential estates were selected from medium density residential areas and their private open space to building footprint coverage ratios were studied to reveal the level of adherence to the Lagos State Urban and Regional Planning and Development Law (2010). The Summary of Local Government Areas (LGAS), Local Council Development Areas (LCDAS) and their residential densities; the name of the residential estates and number of building units present in each estate; the number of building units sampled as well as the number of questionnaires distributed and returned are shown in the Table 3, 4 and 5.

The satellite imagery of the three residential estates was analyzed and the satellite imagery was retrieved courtesy of an educational grant by Digital globe foundation and is as revealed in the Table 6.

3 Results and discussion

The results from the ground truth data reveal that 97% of the residential lots in Apple Estate have a POS: BFC ratio of 30 POS:70 BFC while 3% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC. This indicates that according to the ground truth data, the typical residential lot in Apple Estate has a POS: BFC ratio of 30 POS:70. The RESULTS of the imagery classification data reveal that 59% of the residential lots have a POS: BFC ratio of 30 POS:70 BFC while 20% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC and 14% have a POS: BFC ratio of 50 POS:50 BFC. This indicates also according to the imagery classification data that the typical residential lot in Apple Estate has a POS: BFC ratio of 30 POS:70. In Atunrase Estate, the RESULTS of the ground truth data reveal that 73% of the residential lots have a POS: BFC ratio of 30 POS:70 BFC while 27% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC. This indicates according to the ground truth data, that the typical residential lot in Atunrase Estate has a POS: BFC ratio of 30 POS:70. The RESULTS of the imagery classification data for Atunrase Estates reveals that 64% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC while 36% of the residential lots have a POS: BFC ratio of 30 POS:70 BFC. This indicates also according to the imagery classification data that the typical residential

Table 7 Results from ground truth data (POS:BFC ratio) medium density estates

Name of residential estate	Ratio of private open space to building coverage (POS : BFC)							Total
Medium density estates	10 POS : 90 BFC	20 POS : 80 BFC	30 POS : 70 BFC	40 POS : 60 BFC	50 POS : 50 BFC	60 POS : 40 BFC	70 POS : 30 BFC	
Private estate (Apple Estate) frequency	0	2	62	0	0	0	0	64
Frequency (%)	0	3.1	96.9	0	0	0	0	100
Public estate (Raji Rasaki Estate) frequency	0	17	53	0	0	0	0	70
Frequency (%)	0	24.3	75.7	0	0	0	0	100
Private estate (Atunrase Estate) frequency	0	17	47	0	0	0	0	64
Frequency (%)	0	26.6	73.4	0	0	0	0	100
Average frequency (%)	0	18	82	0	0	0	0	100

Table 8 Results from imagery data (POS : BFC ratio) in medium density estates

Name of residential estate (medium density)	Ratio of private open space to building coverage foot print (POS : BFC) from imagery						Total
	10 POS : 90 BFC	20 POS : 80 BFC	30 POS : 70 BFC	40 POS : 60 BFC	50 POS : 50 BFC	60 POS : 40 BFC	
Private estate (Apple Estate) frequency	0	13	38	4	9	0	64
Frequency (%)	0	20.3	59.4	6.2	14.1	0	100
Public estate (Raji Rasaki Estate) frequency	0	11	59	0	0	0	70
Frequency (%)	0	15.7	84.3	0	0	0	100
Private estate (Atunrase Estate) frequency	0	41	23	0	0	0	64
Frequency (%)	0	64.1	35.9	0	0	0	100
Average frequency (%)	0	33.4	60S	2	4.6	0	100

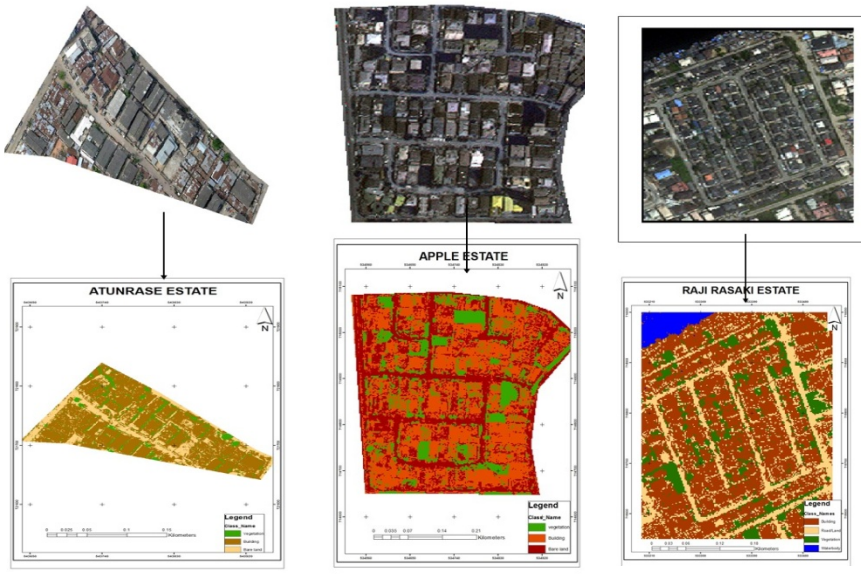


Figure 3 Aerial images of residential estates

lot in Atunrase Estate has a POS: BFC ratio of 20 POS:80. In Raji Rasaki Estate, the RESULTS of the ground truth data reveal that 76% of the residential lots have a POS: BFC ratio of 30 POS:70 BFC while 24% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC. This indicates that the according to the ground truth data, a typical residential lot in Raji Rasaki Estate has a POS: BFC ratio of 30 POS:70. In Comparison, the RESULTS of the imagery classification data reveal that 16% of the residential lots have a POS: BFC ratio of 20 POS:80 BFC while 84% of the residential lots have a POS: BFC ratio of 30 POS:70 BFC. This indicates also according to the imagery classification data that

the typical residential lot in Raji Rasaki Estate has a POS: BFC ratio of 30 POS:70. This information is summarized in the Table 7. Also, the classified images of the selected residential estates are revealed in the figure following the table below.

The images from the results of the imagery classification shows green patches indicative of the greenness observed from viewing, the brown and orange coloured areas depict the built up areas of the residential estate concerned and this clearly shows that there is a dearth of green spaces in the build-up of these communities.

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