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Urban Green Areas per Resident: Review Study

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Abstract: ***One of the essential elements of landscape planning is the design of urban green areas which is important for community welfare. Data about green area in large cities can be collected from aerial survey or satellite imageries. Analysis can be applied using GIS to determine the relation between urban green area (UGA) per resident in the city when statistics of number of inhabitants in the city are known. The computed UGA per resident can then be compared with respect to standard or recommended values given by: World Health Organization (WHO) or by the United Nations (UN) or any other organization. Studying the distances that people need to walk to the nearest green area should also satisfy a certain limit. This paper is an attempt to outline some published research about finding out the UGA per capita in various world cities. Results of such studies can be used as directing issues for city planners to determine how much green area in a city is required and which directions they have to be.***

I. INTRODUCTION

Urban green area (UGA) is supposed to be an important factor to raise human life quality and to create sustainable cities. This has led to the race to create the greenest city. UGA per resident is a quantitative indicator in evaluating urban green infrastructure (Badiu, et al, 2016). One of the major factors considered to classify cities as far as being a good city for high life quality is the UGA per capita and the distance the resident needs to reach the nearest an UGS. The importance of studying UGA per resident in cities arises from the many benefits for sustainable community development (Khalil, 2014).

In this paper, some important benefits and importance of green area per capita in major cities would be outlined. A summary of studies carried out in finding UGA per capita in some world cities would also be given..

A. Benefits Of Green Areas In Cities

The following are some of these benefits, as stated by many authors, for example: Swanwick, et al, 2003; Jason A. Bennie, 2016; Kakoty, S., 2021.

1) Provision of clean and mental health that would reduce stress level and depression, allowing life in a healthy environment.
2) Reduction of urban heat and hence nice weather to be enjoyed and encourage practicing physical activities.
3) Provision of sufficient space for neighbor-hood residents to interact with each other and meet new people.
4) Encouraging kids and youngsters to practice individual and social activities in fresh air.
5) Protection of natural ecosystems since trees and shrubs assist in removing smoke and other air pollutants.

B. Standard Requirements Of Green Area Per Capita

Due to the importance of required green area per capita to achieve at least some of the mentioned advantages minimum required green area per capita in populated citied were suggested by various organizations. Table 1 shows some of such standards:

Table 1: Suggested UGA per capita

Organization	UGA (m^2) per capita	Reference
WHO	9	Khalil, 2014
European Union (EU)	26	Khalil, 2014
German Standard	7	Demuth and Karske, 2011 and Khalil, 2014)
KSA Ministry of Municipal and Rural Affairs (MOMRA)	3.9	Addas, 2020

C. Application of Geomatics in Studying UGA

Preparation of information of green space is important to achieve better management. This can be done through satellite imageries information and using GIS analysis operations. The ability of satellite images, GIS and land mapping in UGA planning was studied by some authors such as Akbari, 2023; Pouya and Majid, 2022; Sun, et al, 2022 and others.

Akbari, 2023 used Quick Bird Satellite Data (QBSD) to produce green space information for parts of Qochan city. His study proved the possibility of producing maps and determining the best place for the physical development of the city. It has been concluded that the use of this technology can overcome many problems and achieve a logical development with the slogan of sustainable development. Considering that preparing UGA map using QBSD and GIS technology in urban scales is less expensive than ground mapping, and it is also possible to update the complications of digital maps quickly, it is suggested to use these images to enrich and update other complications on 1:2000 urban maps. It is also suggested to use GIS technology and form a Geographic Data Base of Green Space for better planning. Akbari, 2023 concluded that satellite data have the potential to perform time series analysis and determine the trend of changes in UGA, and by using existing satellite data, it is possible to evaluate the process of evaluating changes in UGA during the past years.

The aim of the study carried out by Pouya and Majid in 2022 was to use RS and GIS to evaluate UGA per capita in Battalgazi, Malatya. They recommended the use of this technology in landscape design and in making sure of equal UGA distribution.

Sun, et al, 2022 used RS and GIS to determine the landscape pattern index, landscape heterogeneity, and quantitative analysis of the landscape pattern of parks and green spaces in Wuhan City. Using remote sensing technology, they investigated many environmental problems, crisis management in the event of unexpected events, the way the city of Wuhan has expanded over the years, the direction of the physical expansion of the city, the destruction of forests and gardens, from above with a wide view and implement correct planning, also, remote sensing images combined with geographic information system can create communication routes at the city and country level and choose the best routes.

The attempt of studying changes in UGA in the city of Khorramabad, Iran in different periods of time, using aerial photos and QBSD was carried out successfully by Beiranvand, et, al, 2013

A typical study of using Landsat TM/ETM/8 for spatiotemporal patterns and dynamics of UGAs for 70 major cities in China during the period 2000 to 2018 was carried out by Kuang and Dou, 2020. The results showed that the total area of UGS in these cities grew from 2780.66 km^2 in 2000 to 6764.75 km^2 in 2018. In consequence, the UGS area per capita rose from 15.01 m^2 in 2000 to 18.09 m^2 in 2018. They determined and ranked the top ten cities with the highest UGA increment during the study period in China. Table 2 shows the result of this study. It can be noted that city with the highest increase in area of UGS was Beijing where the increment of UGS was 3.25 times that of the other cities.

Table 2: UGA (km^2) in Top Cities in China, from Kuang and Dou, 2020

City	UGA (km^2) in 2000	Increment of UGA (km^2) in 2000 to 2018
Beijing	304.67	516.89
Nanjing	88.95	159.20
Hanjin	88.64	148.22
Shenzhen	156.83	145.04
Changchun	64.07	126.11
Guangzhou	63.12	125.66
Jinan	38.18	124.04
Shanghai	155.21	119.51
Hefei	31.79	117.28
Suzhou	75.85	113.50

In the article by Buket, et al, 2022, the city of Nicosia, Cyprus UGA distribution was compared with the European Green standard. They used Landsat 8 satellite images. The results showed that UGA have a nonhomogeneous distribution throughout the city, and the amount of UGA per capita is approximately 200 m^2.

Integration of satellite images and GIS techniques was found to provide a time and cost-effective methodology for studying UGA, Senanayake, 2013. He applied NDVI method on THEOS Satellite imagery to extract UGA for Colombo city, Sri Lanka.

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II. RESULTS OF STUDIES on UGS in SOME WORLD CITIES

Green parks compose a part of UGA. In their study Pouya and Majid, 2022 determined total green parks area in Seoul as 158km^2. They comment that this cumulative figure is superior to such area in other world cities, Fig. 1. They have also noticed that the major part of green park areas in Seoul fall far from city urban center which makes it difficult to reach.
Statistical indices of urban parks (UP) in Seoul and other major world cities are shown in Fig. 1, Pouya and Majid, 2022.

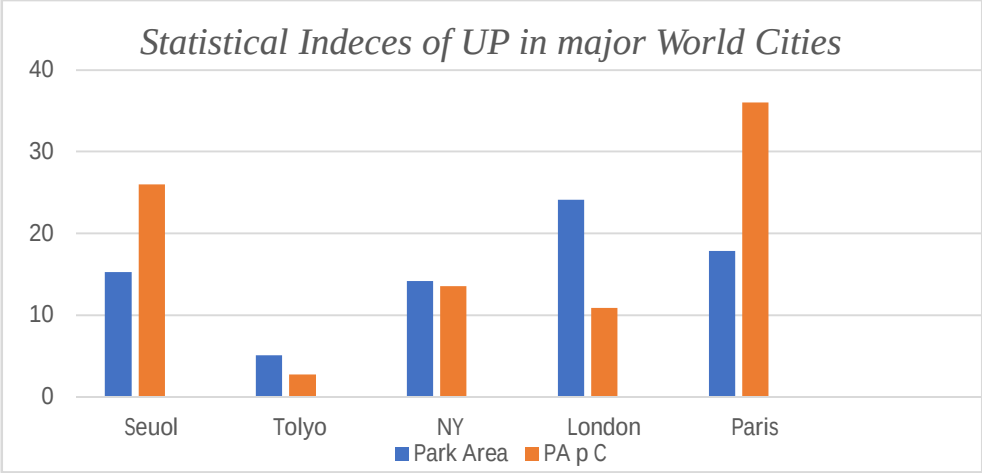

Fig. 1. Comparison of statistical indices of urban parks in major world cities, extracted from Poya and Majid, 2022.

In his study, Khalil, R. 2014 presented an evaluation of spatial equity in distribution of green spaces in Jeddah city, KSA using GIS technology. The study concluded that the UGA per capita in Jeddah was **0.9 m^2** and that **70%** of population have to walk distances that exceed **500 m** to reach green space. In order to achieve 30 m^2 per capita UGA (UN standard). It is also concluded that Jeddah on the west coast od SA is short of about **93,808,406 m^2** of UGA to satisfy the standard. This really confirms what Alhajaj, 2014 stated in his PhD thesis that the UGA in Jeddah was in shortage of about 2 m^2 per capita to satisfy the standard requirement.
During the period 1980 to 2008, Barcelona city's green area saw rapid extension. In this period, Barcelona's UGA has increased by 150% (an annual rise of approximately 5%, as shown in Fig.2 (Barcelona Environmental Report, 2009)

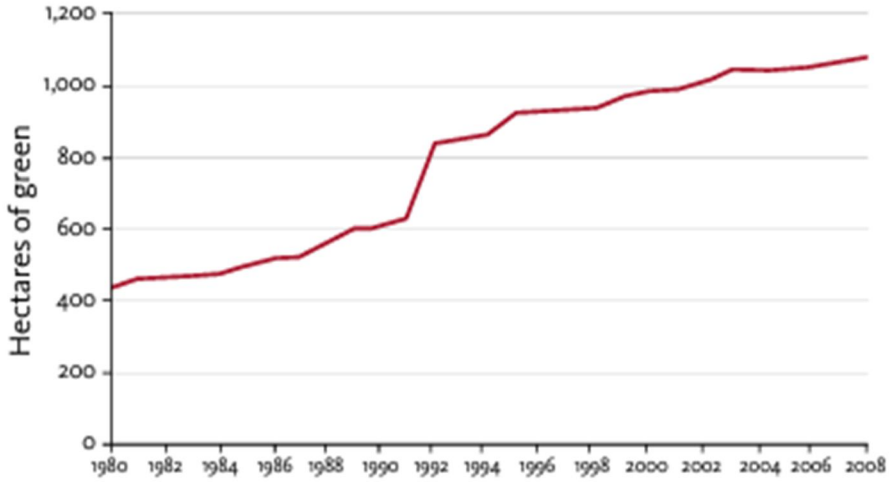

Fig. 2: Evolution of green areas in Barcelona: 1980 to 2008 (Barcelona Environmental Report, 2009)

Barcelona is one of the most densely populated cities in Europe (ESPON Project, 2007; IDESCAT, 2013; Khalil, 2014). UGA in this city is about 3642 m^2 which forms about 36.8% of the total city area and with UGA per capita 6.82 m^2 (Barcelona City Council, 2013), well below the WHO standard (9 m^2 per capita).

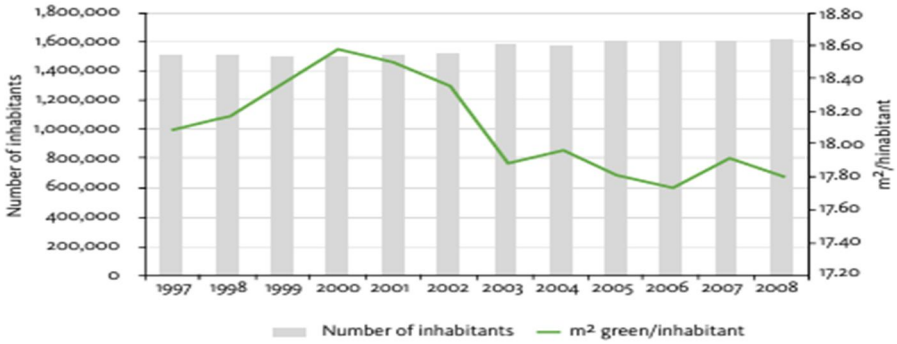

Fig. 3: Green area per inhabitant (Barcelona Environmental Report, 2009)

Vienna can be considered to be one of the huge cities in the world (Olan McEvoy, 2023). The UGA in the city of Vienna in 2018, was 95.37 m^2 which forms almost 51% of its total urban area.

While Istanbul's population has increased from one million to 13 million in the last 60 years, the green areas reduced from 27325 to 8908 hectares with a reduction of 67%. On the other hand, settlement areas increased from 3417 to 22178 hectares in the same period. In the 30 years between 1975 and 2004 GA increased from 1695 hectares to 5435 hectars, while the amount of UGA per capita had dropped from 6.7 m^2 in 1975 to 5.5 m^2 in 2004. This means that the rate of increase in population is higher than GA increment (Samsunlu, et al, 2015).

Bagherian gave data for comparing UGS in various world cities. Figures 4 and 5 below are drawn using data extracted from data given by Bagherian.

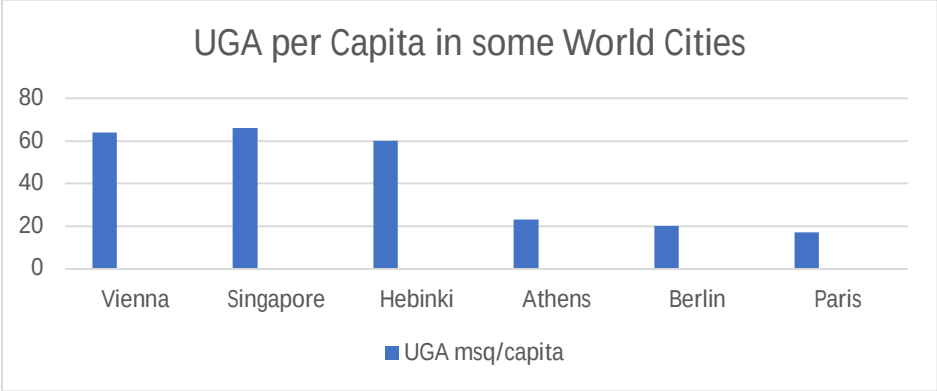

Fig. 4: UGA per Capita in some World Cities

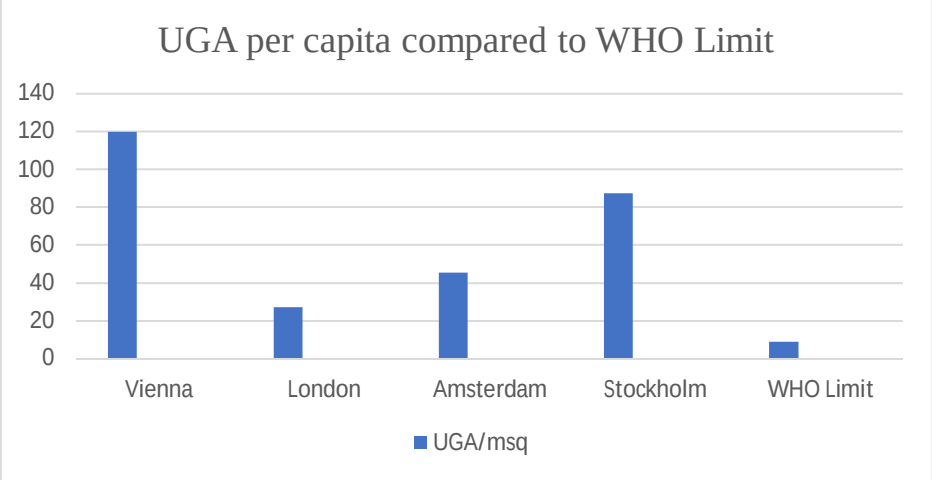

Fig. 5: UGA per Capita in some World Cities compared to WHO Limit

Figures 6 and 7 show Data from Marcelino Vázquez, 2011, for world cities with high and low UGA per capita, respectively:

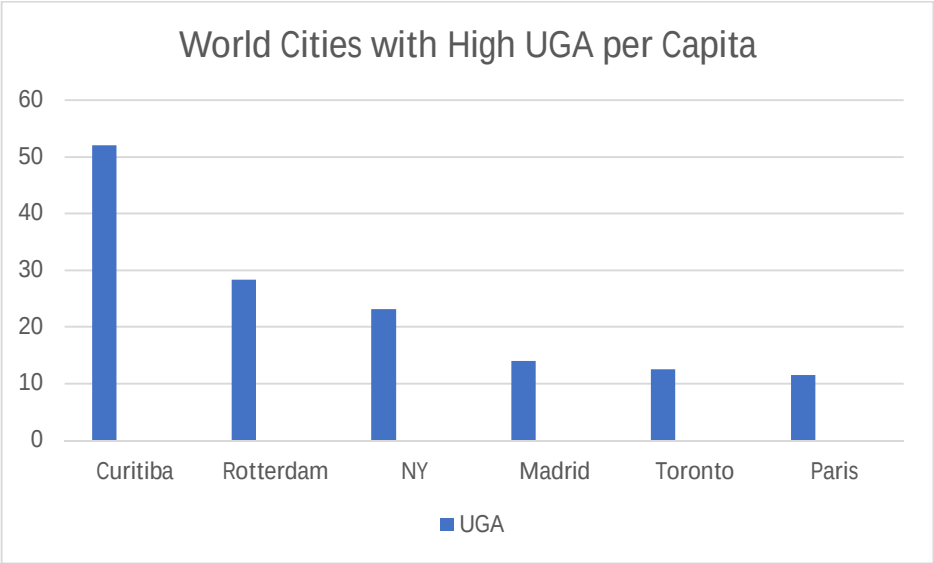

Fig. 6: High UGA per Capita (more than 9) in some World Cities

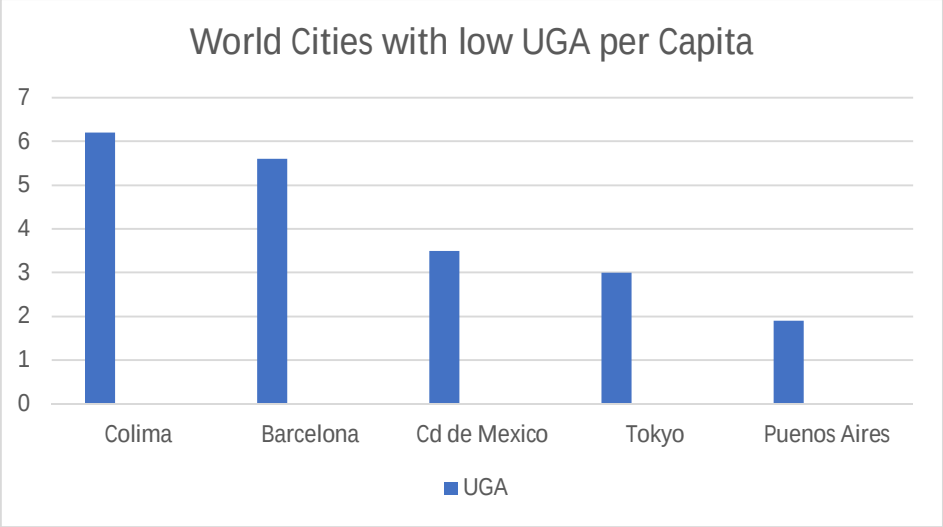

Fig. 7: Low UGA per Capita (less than 9) in some World Cities

Large capitals, like Tokyo and Buenos Aires, provide some of the lowest UGA at 3 m^2 and 1.9 m^2 per person, respectively.

III. RIYADH GETTING GREEN

One of the latest mega projects in Kingdom of Saudi Arabia (KSA) is "Going Green", Olivia, 2023. It is suggested that Riyadh, capital of KSA would accommodate more than 7.5 million trees in another ambitious mega-project in the Kingdom. It has been recommended that Riyadh will enclose 180 000 square meters of green parks before 2030. The aim is to fulfil the 2030 Saudi vision and make Riyadh one of the top 100 cities suitable for most comfortable life in the world. This will definitely for a concrete base for Riyadh to home EXPO 2030

In his thesis, Alhajaj, 2014 has examined ways of increasing POS in Jeddah in both a pragmatic and culturally appropriate manner. He developed three different urban design scenarios to increase walking and other different physical activities in Jeddah.

It is expected that by 2050 almost 6.3 billion people, world habitats, will live in urban areas. Enough green area, with park walking distance not to be larger than 300m should be available for healthy life.

IV. CONCLUSIONS & RECOMMENDATIONS

The main reason behind decrease of UGA per capita is the high increase of population growth in many world cities. This leads to the poor environmental quality of life in world cities and should be encountered by increasing green areas through urban planning to fulfil suitable distances to green spaces.

Unplanned constructions and settlements in world cities may contribute to great decrease in UGA per capita. Suitable distribution of green spaces should be taken into consideration during the process of urban planning.

From the published UGA per capita in various world cities and from standards of suitable UGA per capita given by different specialized organizations it will be recommended that 10 m^2 per capita should be the minimum when planning new cities or replanning of existing cities to fulfil comfortable life.

Aerial photos and satellite imageries can be a good data provision for urban planning and distribution of green spaces in cities.

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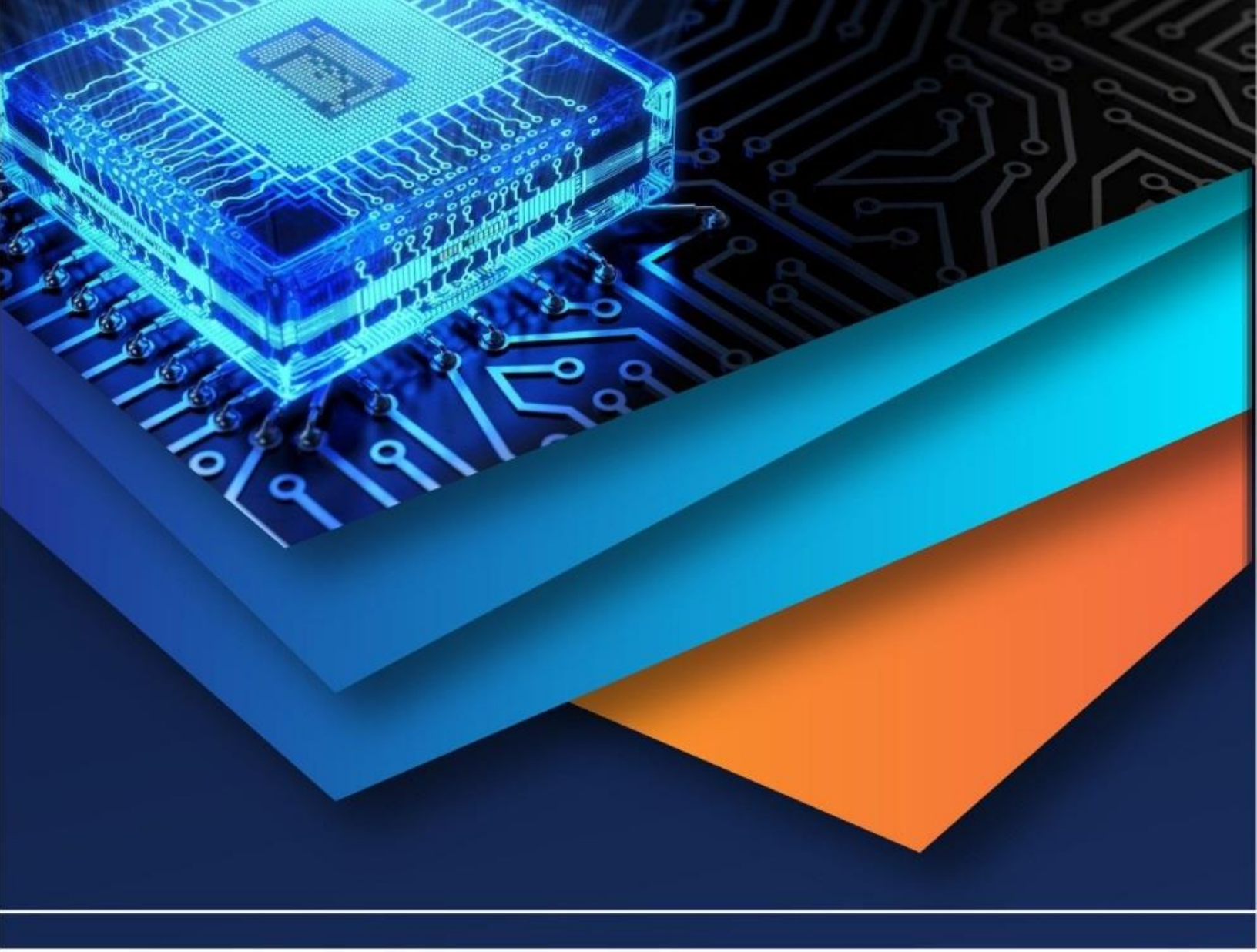

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