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The Potential of Blockchain within Air Rights Development as a Prevention Measure against Urban Sprawl

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Abstract: The rapid rise in urbanization internationally is both driving and stressing our consumption patterns, including that of land use. Urban sprawl is arguably one of the most important threats to human and nature biodiversity given its reliance upon fossil fuel exploitation and consumption. The need for increasing the density of cities is required to contain urban expansion in land size. However, while the footprint density of cities is increasing, vacant plots are prized and rare in most urban areas. Tradable air rights development is seen as a potential solution to provide developers the option of increasing density while encouraging an emerging urban economy. However, the price speculation of air rights is a danger and counter to a fair and inclusive real estate market. This paper proposes a new model that encourages the trading of time-sensitive air rights through Smart Contracts in the Blockchain as a means of prevention against urban sprawl.

Keywords: blockchain; smart contracts; air rights; urban sprawl; urbanization; air rights development; floor area ratio

1. Introduction

Urban Sprawl can be defined by the movement of people from populated and expensive urban centers to suburban areas characterized by low density residential development, with curvilinear street patterns and separate social amenities accessible only through the use of automobiles [1]. This pattern is evident today in both Western and Eastern cultures, and on all continents.

However, this human movement is not limited to urban–suburban migration but also reflects the increasing movement of people from rural areas into sub-urban areas, often creating cultural enclaves. Cities such as Sydney in Australia, Kuala Lumpur in Malaysia, Mumbai and Chennai in India, Los Angeles in the United States, Cotonou in Benin, Shanghai in China and Port Louis in Mauritius all reflect this pattern. However, a similar pattern is also evident in the dense urban areas of major metropolises predominantly due to rural immigrants seeking residency inside these dense areas to enable easy access to employment opportunities. Cities such as Chicago and New York in the United States, London in the United Kingdom, and Melbourne in Australia reflect both these patterns.

The reason to move to sub-urban areas, instead of urban areas, predominantly relates to the issue of affordability [2]. This migration means that urban limits initially defined by municipalities or urban governance regulatory bodies are more often disregarded, resulting in urban boundaries stretching into lands reserved for purposes other than urban development or that have become visually redundant and unoccupied by their owners or managers. In this context, Bhatta [3] has argued that urban sprawl should be seen in terms of unauthorized, uncontrolled and unplanned developments that sprout uncontrollably at the peripheries of urban centers. Similarly, Agrawal [4] and Sudhira and

Ramachandra [5] assert that these sprawls cause major setbacks in the implementation of mainstream urban planning governance strategies and mechanisms. Such is thereby resulting in the ill-management of urban areas that would philosophically otherwise be venues that have an equality of tangible and intangible services, accessibility, and opportunities.

There are many academic and policy reasons that explain the nature of urban sprawl [6,7]. From an economic perspective, it has commonly been concluded that the higher cost value of land and property in inner urban areas results in a lack of affordable housing that contributes to urban sprawl. This is because hosting affordable housing is attractive because of the cheapness of both land and housing construction in suburban and peri-urban areas [8,9].

In part, as a result of this dilemma, and as a consequence of the urban planning profession looking for innovative micro-level urban planning governance mechanisms, the concept and implementation of air rights development (ARD) and transfer of development rights (TDR) in several statutory planning schemes internationally have allowed developers to scale buildings to new heights [10,11] while addressing statutory planning heritage conservation, and/or affordable housing, and/or urban open space provision statutory incentives or requirements. Such mechanisms have often been drafted to conserve the physical and social characteristics of a city and/or urban places within. This new ARD model has triggered a developer interest for accessing such ARD and TDR opportunities where it enables greater economic gain or strategic (tangible and or intangible) economic returns in either short or medium terms. It has also, indirectly, forced the price of available land to rise as developers seek to garner strategic land allotments. In addition, urban housing demands are increasing and there is a notable mismatch between demand and supply [9]. These patterns are reinforcing a trend for housing development to occur in suburban or urban peripheries, with prospective home owners or leasers looking for more affordable options.

While there is a plethora of literature on urban sprawl in various disciplines, there has been little research into the linkage between air rights as a mechanism to strategically regulate the real estate market while allowing urban fabric densification to host housing and to mediate and delimit urban sprawl. Similarly, any possible link between ARD and biodiversity in the literature is also missing. This paper offers a possible novel approach that can help in better managing contractual statutory development engagements with an aim of protecting the biodiversity and enable increased urban housing opportunities through an indirect manipulation of real estate prices.

2. Air Rights Development

Air rights, by definition in the urban planning discipline, refers to the right to occupy (including develop and/or use) the space above or below the earth's surface. Although this right, as explained by Goldschmidt [12], can be limited due to various planning and legislative factors including aviation traffic flight paths.

Historically, the concept of air rights dates from 1797 when it was discussed as comprising 'space ownership', being either above or below the surface, and being indefinite in scale and dimension. Such a concept was echoed in the Latin legal maxim, '*Cuius est solum, eius est usque ad caelum et ad inferos*', that translates to 'For whoever owns the soil, it is theirs up to Heaven and down to hell' [13,14]. This doctrine, as explained by Schwartz [15], was later incorporated into both English and United States of America (US) common law. With the advent of the airplane in the 20th century, the occupation of space above the earth was limited to 'within the range of actual occupation' [16]. For this reason, the definition of air rights began to be interpreted as an economic commodity. Finn [17], for example, interpreted the concept as 'Unused and excess development rights gauged, like building density or lot size, by the square foot and transferable, when zoning permits it, from on buildable lot to another' [17].

The concept of air right development first legally arose in 1797 in the *Slate vs. David* determination, by the British court in their Colony of New York. In this determination, the defendant was accused of hiding two barrels of herrings (*Clupea harengus harengus*) 15 feet (4.5 m) under his yard. In the ruling, the court determined that anything above or below the space occupied by an individual's

property belonged to them. Until recently, this legal precedent was being applied in its literal meaning; hence, it gave relief to those who feared trespass and eviction by others who, for one reason or another, experienced invasions of spaces above or below their properties or lands [18].

In the US, the concept was formalized in 1908 when New York City's (NYC's) Grand Central Terminal, on 89 East 42nd Street (on a corner of Park Avenue), air rights development was initiated. The construction of the terminal allowed for an integrated development of an electrified railroad, a street, together with residential and office spaces [19]. With the success of this air rights development, which took approximately 5 years to plan and construct, by 1929, there were over 18 skyscrapers built in NYC adopting the same procedure of air rights development [12]. This trend, spurred by the increasing demand for residential properties, as well as urbanization [10], has been prolific in North America as well as in many European cities including London.

Chau et al. [20] and Barr [10] argue that skyscrapers, borne out of air rights development, often create 'iconic' identities for their host city, often resulting in an increase the economic and cultural status of the urban precinct the building is located in. For example, 57th Street in Manhattan in NYC is now labeled as 'Billionaire's Row' due to the number of gigantic, executive, luxurious and classic design projects that are increasingly being erected along this street [9]. Another attributable reason, as discussed by Florida [21] and Lachman et al. [22], is the new generation of homebuyers—the 'Millennial generation'—who are 'shopping' for mixed-use and higher locations (in terms of views and aspects) and properties that offer 360° views together with spaciousness and abundant light, and as a consequence attract higher re-sale values [17,23].

But there are challenges posed by air travel and its associated technologies to air rights developments. These factors include: the need to conserve/preserve green spaces (such as the Highline Park project in NYC); enable different transportation options; enable different mixes of land use; and the urban planning desire to integrate land use and transportation with compact building designs [24]. Amongst others, these factors are increasingly posing new challenges to urban planners and policy makers. The most recent (December 2018–January 2019) dilemma of air rights has been the use of (public and) private drones that have significantly affected flights at Gatwick and Heathrow airports.

The scarcity of developable spaces as well as high property prices in the form of rentals in urban centers is increasingly the driving factor that has warranted increased attention for air right developments. Spaces over railroads, freeways/motorways, car parks, thoroughfares and other such areas have been appropriated as new development spaces and areas that could cater for new communities and jurisdictions to apply 'Smart City' growth idea applications, especially if they enable the implementation of mixed-use and digitally-rich environments. Within this context, such developments are promoted as being more sustainable, that they attract fewer servicing costs, and can lead to higher tax revenues. The same are credited with the conservation/preservation of green spaces and availing spaces for walkways and bike paths [25]. It is worth noting that these air rights could be either privately owned or publicly owned (or a mixture of both) depending on the owner(s) of the land in question and their transferability rights.

It is worth noting that the majority of the formative air rights developments were undertaken over railways because railway line alignments and their stations were deemed to be highly (economic and cultural) valuable land spaces due to their attraction of higher user gathering frequencies and commodity sale demands. As time has progressed, the concept of air rights development has spawned more variations. These developments are increasingly visible and acceptable in a wide array of public and private assets including car parking venues [24,26], certain landmarks including churches Mazzara [27], and even in private places. The $ prices the air rights transfer (whether existing $ or prospective $) fetches is another variable influencing (public and/or private) stakeholders to consider transfer of air rights development because of the potential economic (and often cultural and political) returns from such investments [17,28]. For example, Federation Square in Melbourne, Australia,

which is a major node, visual icon, cultural center and often misused as a political 'football' by state and local governance political representatives, is a prominent Australian exemplar.

Air rights development has gained notoriety as being one of the most lucrative investments that many developers are attracted towards. Similarly, land owners and individuals with smaller buildings, such as landmark servers, are earning higher profits from the sale and transfer of their property's development rights to developers.

Because of the evident economic benefits accruable from the implementation of air rights developments, cities such as NYC, Chicago, Boston [8], Los Angeles, Portland, Seattle [29], São Paulo in Brazil, London, Melbourne, Sydney, Adelaide, Perth, Ottawa, Vancouver and Calgary are just a few that have resulted in notable, design award-winning, 'iconic', visible and landmark infrastructure or complexes. As early as 1908, Goldschmidt [12] recorded that numerous projects that informally or unofficially involved air rights development were already complete, or were in the different stages of completion. In contemporary US cities, there are a number of luxurious projects courtesy of air rights development provisions, or its more recent urban planner terminology of 'Transfer of Development Rights' (TDRs). TDRs continue to provide solutions for numerous planning challenges, including major improvements to infrastructure, construction of affordable housing and office spaces, provision of improved services such as walkways and bike paths, and also environmental conservation [30].

3. Smart Contracts, Blockchain and the Property Market

The technological digital revolution in the last 20 years has seen the emergence of new systems and technologies that are reputedly more efficient and reliable [31]. Likewise, Smart Contract technology has evolved as a means to replace the traditional forms of contracts that promote transactional safety, efficiency and reduce possible contract breaches. Kosba et al. [32] contend that the Smart Contract system, based on Blockchain technology, is an efficient, reliable, and secure decentralized system that can aid TDR administration. Essentially, Smart Contracts are built into a novel Blockchain process that is characterized by distributed consensus, and assumes the existence of no conflicting computational resources [32,33].

Blockchain technologies, originally termed 'block chain', is a growing list of e-records, called blocks, that are linked by cryptography. Each block contains a cryptographic version of the previous block, accompanied by a timestamp, and transaction data. By intent, a Blockchain is reputedly resistant to modification of the data.

The real estate discipline has sought to host both open and secret property transactions and Smart Contact systems. Deloitte [34], have concluded that the commercial real estate industry has applied Smart Contracts to service key aspects of their operations a confidential arena to maintain competitive advantage. Smart Contract details, such as rental rates, prices of different properties, details of air right development transactions and valuations, amongst others, are not readily shared with the public. On the other hand, driven by a data-rich era, those details often come to light. Consequently, buyers are becoming impatient and want more openness, efficiency and transparency in TDR property transactions.

To their advantage, technological advancement in various fields has contributed greatly to the real estate market. One of these advancements is through the introduction, and later quick acceptance, of Blockchain technology. Borrowing from the words of Turk and Klinc [35]: 'this technology allows for distributed, encrypted and secure logging of digitized transactions'. As such, issues of inefficiencies and inaccuracies are no longer relevant to transactions in the real estate industry.

One of the key areas that Blockchain technology has truly advanced is in dealing with property transaction contracts, which are ubiquitous and any financial transactions invariably involve a third party [36]. With Blockchain technology, there is the notable possibility to use the concept of Smart Contracts; hence, the ability to improve on transparency, efficiency, trust, speed, and to reduce hardcopy paper trails amongst many other benefits [32,37]. In the real estate industry, and more so in property transactions involving the sale, purchase and transfer of air rights development(s), Smart Contracts are

recognized as bringing benefits including: (i) Accuracy [38,39]; (ii) Transparency [39–41]; (iii) Speed and Efficiency [42]; (iv) Security [43]; and (v) Cost reduction [44,45].

As argued by the authors, Blockchain technology offers the possibility of exploring the concept of Smart Contracts in transactions involving air rights developments, in view of the benefits that stakeholders would accrue from its adoption.

4. Price Uncertainty for Transferable Air Rights

The validity of air rights use has been commonly used in the US as a means for capital raising for various projects [46]. However, it has been noted by Clinch and O'Neill [47] that there is uncertainty when dealing with development charges and transferable development rights in unique urban planning examples. Clinch and O'Neill [47] argue that there is very little analysis, evidence and instruments in place that can assist urban planners to quantify pricing. Because other researchers also highlight the gap between policy and practice, this demonstrates a need for a policy-based approach to regulate the pricing of ARD. Shahab et al. [48] argue that one area that causes the price uncertainty for ARD is the issue of transaction cost that includes costs incurred during designing and implementation of the ARD. Their reasoning is that the distribution of such costs varies depending on the policy approach regarding institutional design and arrangement.

Baird-Remba [49] shares what is known as the '90% rule' that was adopted in West Chelsea, NYC, as one of the potential solutions to solve the pricing quagmire. Although this strategy applies only when the remaining ARDs are approximately 10%, the municipality is able to ensure that owners and developers are not exploited by sellers who may take advantage of scarcity and sell at exorbitant prices. Similarly, by so doing, they also ensure that developers are able to set aside the mandatory 10 to 20% of their units for affordable housing. Through this end, King County [50], Brooklyn, NYC, promotes the need to have an 'ARD bank' which is used to bridge the gap between landlords and owners/developers. It also serves as a revolving fund that fosters the protection of land and finally, allows municipalities to acquire ARDs from landlords and resell these to developers at a later date and at reasonable prices that are fair to all parties involved in the transaction [51]. Furman Center [52] proposes an adjustment of the pricing for ARDs by adopting the consumer price index (CPI), that allows the parties involved to compare prices paid in different times. This strategy has been used in NYC and it is reported that both buyers and sellers have been able to experience fairness during transactions. The case of New York is further explored in the section below.

5. A Proposed Model

Through a cost review and appraisal of tradable air rights, it can be observed that prices are dictated by market rates, often controlled by speculation. To encourage a fair and inclusive economic market place, a new model is required that is specifically designed to discourage urban sprawl. It is argued that the pricing of tradable air rights is inversely proportional to available remaining land.

If there is a vast quantity of land available in the suburbs of a city, the pricing will thus be low, thereby encouraging higher buildings and densification. If there is a small quantity of land available, the price will be increased to match market rates. This will encourage the preservation of green space in the city or can enable greater public open space conservation/preservation either in private or public land ownership modes. It is argued that price lowers, to a competitive market rate, when the number of green spaces reduces to keep a healthy equilibrium with real estate prices. In addition, by the time this scenario presents itself, the urban fabric will be highly densified, and thus the demand for land will be higher.

Figure 1 proposed a model through Blockchain technologies whereby owners can trade both land and air rights through Smart Contracts. Through this method, it is argued that air rights are time-sensitive, and thus have an expiry date. On that date, the air right reverts to the underlying owner to allow the latter to further trade that space. In Smart Contracts, the developer who previously

benefited from air rights, and built accordingly, will have the option of either demolishing or paying the municipality a fee to maintain the building height.

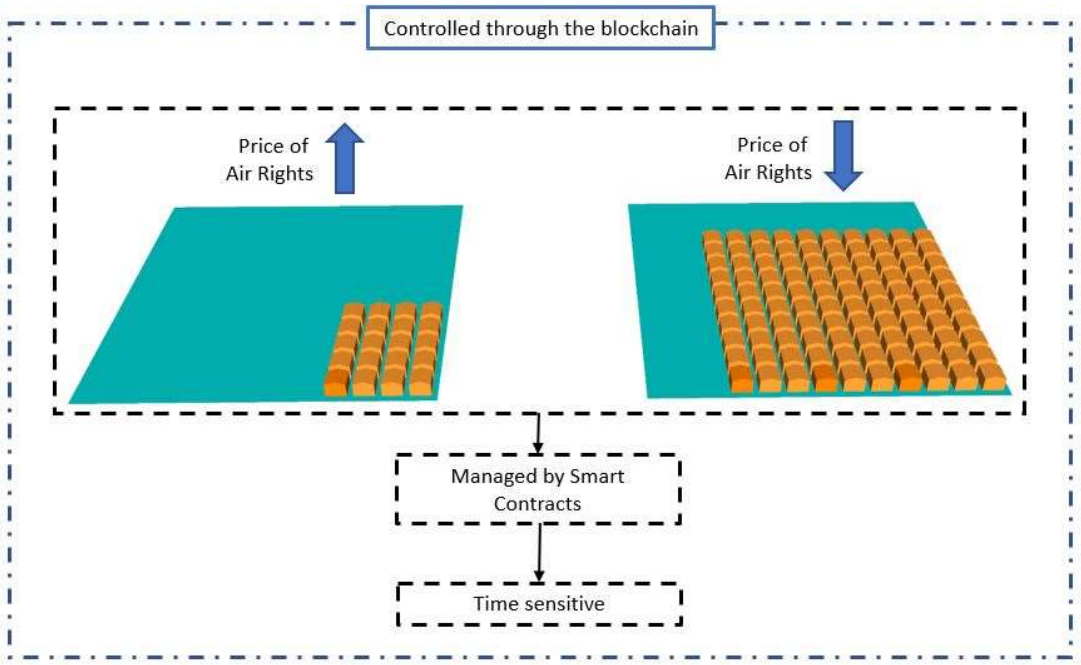

Figure 1. Proposed model for time-sensitive air rights trading through Smart Contracts (illustration sourced by authors).

The proposed model addresses four dimensions:

1. Fluctuating prices calculated based on green land availability;
2. Smart Contracts;
3. Time-sensitive conditions;
4. Blockchain ledger systems.

6. A Case Study of Air Rights Development in New York City

The case of NYC [53] is considered in this article drawing upon the record number of air rights developments in NYC [54]. Factors influencing air rights development in NYC are similar to those affecting other cities, and the only difference arises in the pricing of those rights (including the continuance of rent control restrictions) and the cost implications of implementing projects that adopt air rights development concepts.

Been and Infranca [55] conclude that the concepts of ARD and TDR are deeply rooted in NYC. A precedent often pointed to is on the famous Park Avenue that involved using air space above the railway line in New York Central Terminal. This project provided a precedent for many other similar developments in NYC. According to Goldschmidt [12], by 1929, there were over 18 skyscrapers that had adopted a similar techniques to this Park Avenue precedent. Investments of a similar nature have continued to be erected include the Paramount at 432 Park Avenue, and the 75-storey One57 (formerly Carnegie 57) at 157 West 57th Street. The former is promoted as the tallest residential building in NYC, with One57 attracting the most expensively sold penthouse (laid over the 71st and 72nd floors) for US$100.47 million [54].

The photo below (Figure 2) is that of the 'Billionaire's Row' depicting how air rights development can drive a city to render a unique symbolic identity.

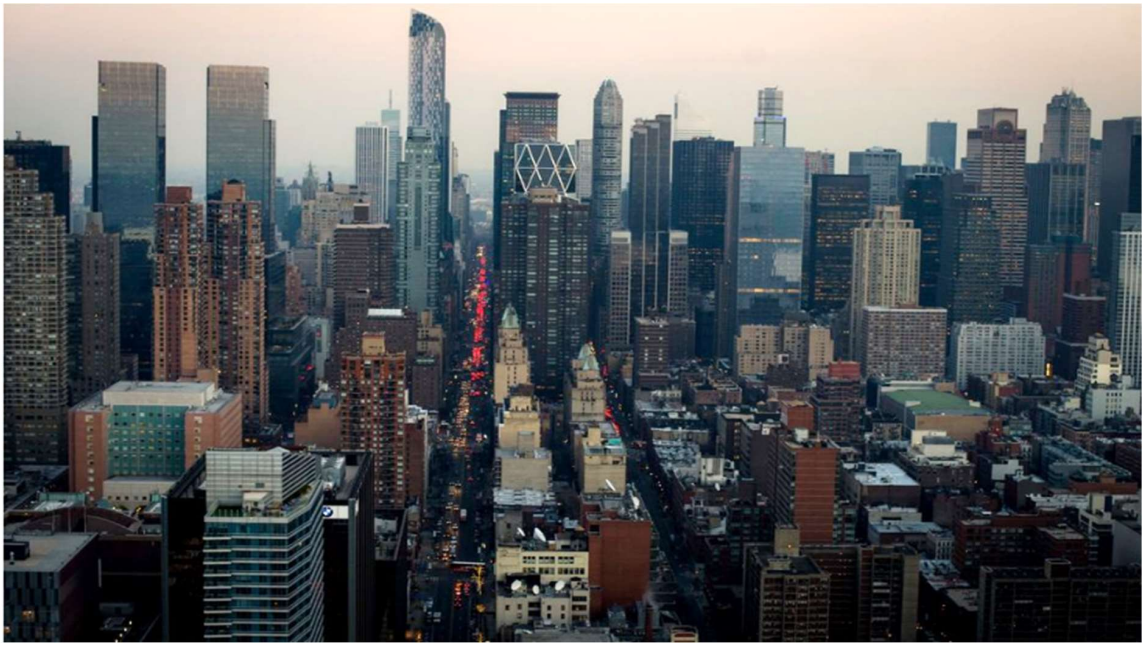

Figure 2. The Billionaire's Row [9].

ARDs in NYC are driven by a number of factors. Among them is the availability of TDRs, which, in 2016 alone, was reported as involving up to 1.6 million of square feet (148,644.8 m^2) of land being traded with the number of unused development rights involving beyond 3.7 billion square feet (343,741,248 m^2) [56].

Another major reason behind the increase in number of air rights development projects in NYC is cost. This is true especially from the perspective of added income by both the seller of the transferable rights and the developer who benefits from the sales of (rental) houses, apartments, office space and/or other facilities associated with a project. For municipalities, TDRs of public spaces, such as railway stations and car parking lots, allow for extra rate revenue, availability of affordable housing, and improved infrastructure [24,57,58]. As noted by Colman [13], air rights in NYC are almost three times higher (at US$225 per square feet) than the average price of a square foot (US$64.44) in most parts of the US. Such prices are so attractive that air right development projects in NYC keep mushrooming.

To put this in perspective, in 2018, the recently announced JP Morgan Chase project included the demolishing of its existing headquarters to enable the construction of a 1200-feet tall (365 m) 70-storey building on NYC's Park Avenue to house its 15,000 employees. It was reported that:

> 'The building would be the first skyscraper to go up under new zoning rules for the area surrounding Grand Central Terminal, which were designed to encourage the development of taller, more modern skyscrapers and ensure that Midtown remains one of the city's premier business districts. The new tower will soar as much as 500 feet [152 m] higher than the existing 52-story headquarters on the west side of Park Avenue and contain an additional one million square feet of office space. Chase is expected to buy unused development rights from nearby buildings, generating more than $40 million for public improvements to the streets, pedestrian plazas and sidewalks in the neighborhood under the new zoning plan.'

The proposed project would cost JPMorgan Chase approximately US$4 billion. To actualize this project, JPMorgan Chase would need to buy unused transferrable development rights from nearby neighbors and, in so doing, it is estimated that it would result to a revenue of beyond US$40 million that the NYC Council could use to improve public amenities such as streets and sidewalks amongst others [59].

TDRs thus involve a number of transactions that ultimately allow owners of unused spaces, small buildings and/or landmark servers to sell and transfer unused development rights to another land owner or developer [28,60,61] as shown in the Figure 3 below.

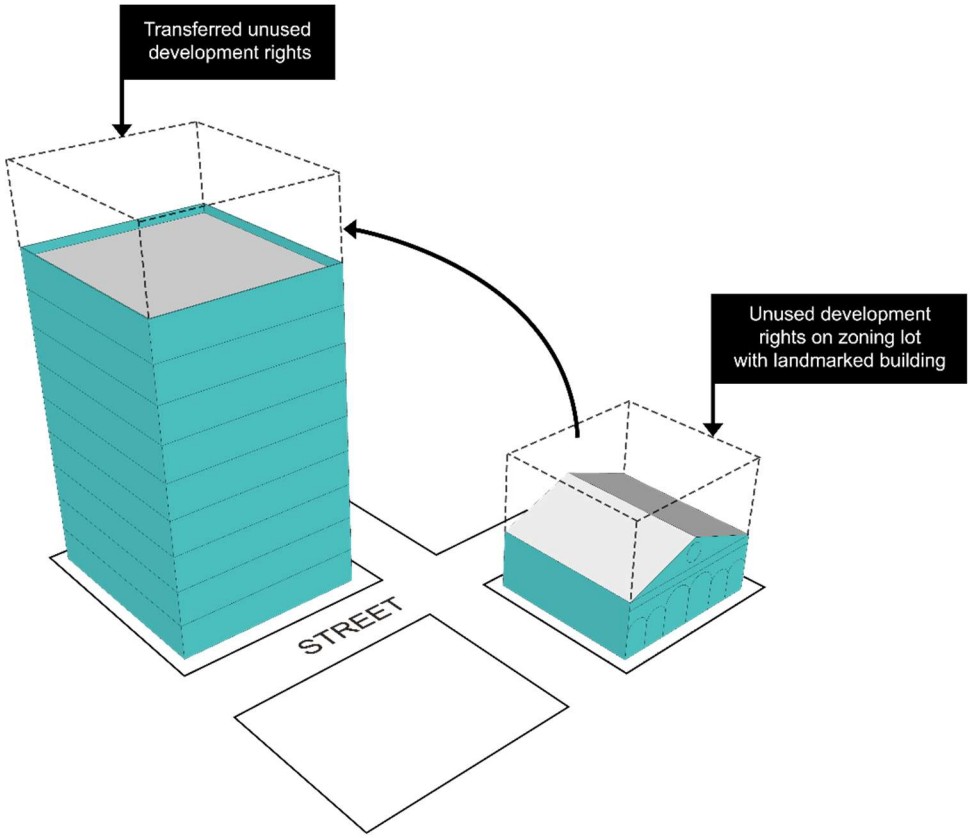

Figure 3. Transfer of development rights (illustration sourced by authors).

With the billions of square feet (m^2) of unused (and transferable) spaces in NYC, these TDRs are manned using zoning resolutions that were introduced and enforced from 1916 [62], as amended in 1968 and 1977, to ensure strict measures are observed when private developers and non-profit making organizations are transferring or buying development rights [60,63]. These zoning resolutions, as Goodman [64] concludes, encapsulates the need for sustainable growth in NYC and the importance of complementary land use controls. Goodman argues that the twin issues are controlled through a zoning lot merger, which is part of the larger TDRs [65]. With a zoning lot merger, which involves merging two or more adjacent zoning lots into one (as shown in the Figure 4), unused development rights can be made to be transferred to one another [53].

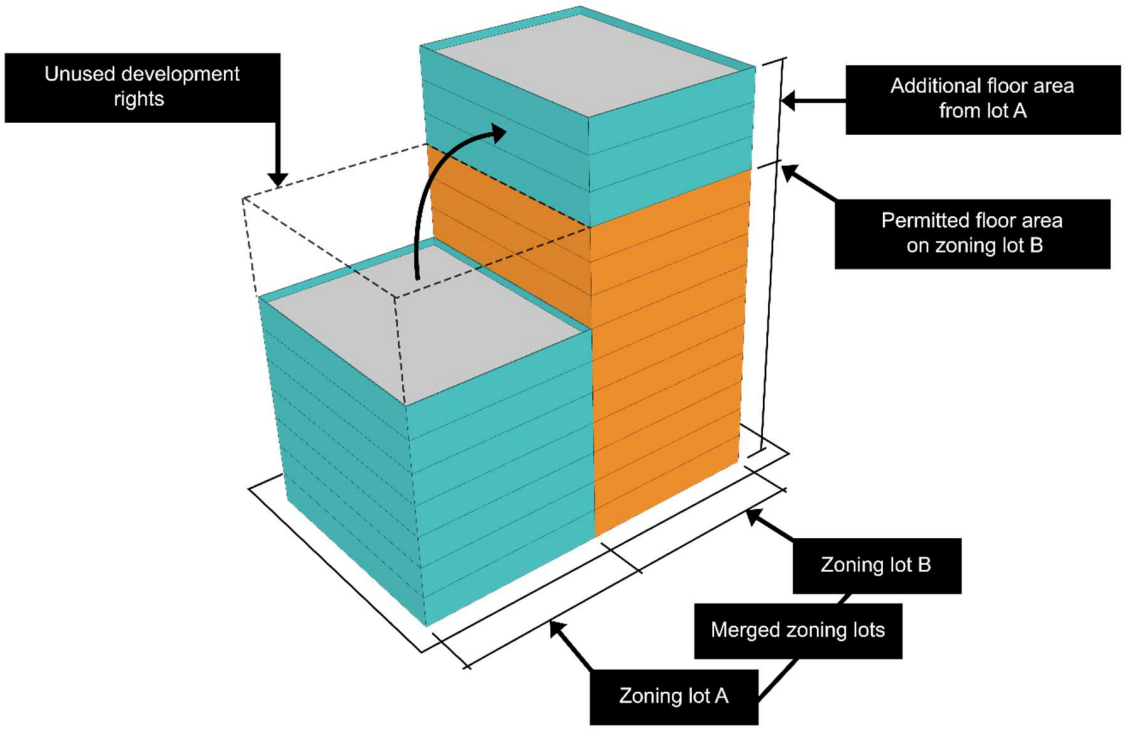

Figure 4. Plot mergers (illustration sourced by authors).

According to Marcus [65], a zoning lot merger is controversial since it raises environmental sustainability questions, especially in a ballooning urban population, which in turn places significant pressures upon density levels.

Problems in density levels can be resolved by adopting a Floor Area Ratio (FAR), which prescribes that each building lot in the city has a limited amount of volume and operational floor area that can be utilized [60]. Figure 5 shows an example of how a FAR is calculated.

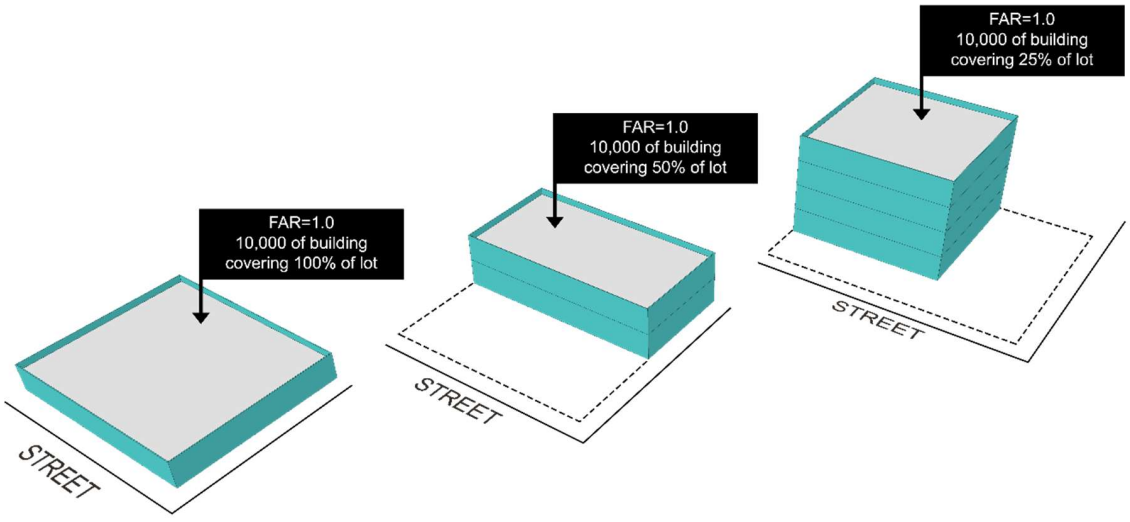

Figure 5. Floor Area Ratio calculations (illustration sourced by authors).

Just like a zoning lot merger, the FAR also has a degree of controversy because it has raised legal dilemmas in regard to the equitable allocation of TDRs and the nature of economic and social interest(s) being transferred [64,66]. Joshi and Kono [67] argue that several US cities have been prompted, because of FARs, to impose maximum floor area ratios to address negative population externalities. Joshi and

Kono [67] conclude that, to achieve this, both the maximum and minimum FARs should be considered because the maximum FAR, which has been the norm, is insufficient in controlling population increase. If this scenario is coupled with the minimum FAR, which dictates the minimum building size that can be built—hence, preventing underdevelopment—an optimum population density is achievable. While the TDRs provide increased benefits to the urban form, it is a cumbersome process for urban city councils as those represent manual work and with increasing demands for those, timely and effective responses are difficult to achieve. To address this, the authors of this present paper propose to introduce the concept of Blockchain and Smart Contracts in the management of such structures and in the regulation of its prices. The proposed approach is presented in the section below.

7. Discussion

The models of air rights development and the transfer of development rights are sound urban planning strategies and are feasible in many cities of the world, especially those facing housing challenges and high land values in cities. Despite this, there are some challenges that need to be surmounted to yield benefits from air rights. A summary of highlighted benefits is detailed in Table 1.

Table 1. Identified benefits of air rights.

Environmental conservation/ sustainability	• TDRs and air rights development have been seen to help in the reduction of the environmental impacts of major transportation routes and interchanges. With such projects implemented, where pedestrian amenities (e.g., bike paths and walkways) are provided and improved, usage of an automobile is minimized, thereby helping to reduce emissions of greenhouse gases such as carbon monoxide (CO) [68]; • Provide density to support the transit network by providing for alternative transportation means, which ultimately helps in reducing the emission of harmful gases [24,69]; and • Creation of green spaces.
Social impacts	• Reconnecting neighborhoods and urban areas altered by transportation routes [30,58]; • Providing opportunities to improve transportation infrastructure; • Helping in solving housing problems by accommodating an increasing population in a sustainable way [29]; and • Improving the safety of pedestrians, railways, bus, and road users.
Economically	• Revenue creation through new tax generation from facilities that are included in the projects. Such facilities, like residential and/or commercial offices, earn local government revenue in the form of taxes imposed upon the rental fees, amongst others [68]; • Job opportunities: projects of large-scale magnitudes are important in creating new employment opportunities. New facilities, such as residential areas, departmental stores, shopping malls, offices, entertainment venues and many others, increase the opportunities for job seekers to secure decent jobs [11]; • Sound planning: with air rights developments, zoning lot merger principles are employed which promote the sustainable growth of the city and also allow for mixed-use of public and private spaces; hence, promoting order in the city [28,70]; • Allow for expansion: with air rights developments, cities are able to expand since more housing units, office spaces, social amenities increase, as well as improving infrastructures [71]; • Support the private market due to the increased number of people who settle in residential units, and thus use the social and public facilities in highlighted projects.

From the foregoing research discussion, and the case study of NYC, it is relevant stating that the numerous challenges that cities grapple with, such as housing problems, underdevelopment, congestion, traffic accidents, environmental degradation and planning problems, could be substantially addressed by pro-actively adopting the concept of air rights development. As Goldschmidt [12] has demonstrated, since the first air rights development project commenced, there has been no looking back on the possibilities this strategy offers. Numerous projects have been completed that have

completely changed the physical image and identity of cities for the better. Housing problems, prompted by increasing population, can be substantially addressed through residential spaces being creatively incorporated into building developments crafted under these concepts that would otherwise be relatively expensive. The models also prove creative opportunities in enabling numerous job opportunities through direct employments and the creation of office spaces facilitating where new work venues and clusters are created. The pooling together of different facilities in a given area also helps improve service delivery, thereby helping to generate revenue and allowing for efficient and sound urban planning.

Numerous authors have attempted to demonstrate how Smart Contracts, through Blockchain technology, could benefit the real estate industry [34,72–74]. A common denominator by these authors is that Smart Contracts are viewed as the modern solution to many of the challenges that have been bedeviling the land and real estate industry. Although there is no outright mention or advocacy of air right developments in these discussions, issues to do with the transfer of title deeds, registration of title deeds and the sale of properties have been widely discussed.

Thus, the position of Smart Contracts in facilitating and enabling air right transactions is considered to be the new digital-rich platform of exchange.

In support of Smart Contracts being used in deference to traditional title deeds and property ownership transfer documentation and processes, a relevant precedent is offered by Moloney [75] in analyzing the challenges the Haitian authorities and international agencies faced in re-settling the victims of the earthquake in 2010. According to Moloney [75], numerous title deeds and land registry records were destroyed during the calamity; hence, there was no reliable method to determining legally rightful land owners. If such records had been captured using Smart records, theycould have been easily recovered in a public e-ledger subject to no manipulation.

Apostalaki et al. [76] argue that Smart Contracts have one of the highest level of security mechanisms. Romano and Schmid [43] affirm this argument by highlighting how this technology incorporates high encryption levels for data despite its use by both private and public viewers for reading and recording the transactions of each Blockchain, as well as in executing transactions.

Through Smart Contracts, pre-sale due diligences are expedited, hence, saving both time and money [34,77]. This then reduces the need for intermediaries, who are part of the air rights transactions [78,79], who eventually contribute to increased service charges and add to the risk of human errors that may eventually prove costly. Smart Contracts thus pose the perfect platform for such markets.

A salient feature of the proposed model is that it responds to market demands by ensuring a fair, inclusive and equitable trade process. The price of air rights is envisaged to lower where there are large green areas in suburbs, thus encouraging developers to densify the urban fabric. The price is then lowered inversely proportional to green space diminishment. This ensures that equilibrium in price occurs. The management structure, being through the Blockchain, known as a trust-based system, ensures a timely and responsive service, which increases the performance and efficiency of urban governance and management. The use of Smart Contracts through the proposed model also ensures trust, as it provides accurate and immediate actions through its self-initiating protocols. However, to ensure the actualization of this concept, there is a need for the harmonization of protocols and standards to ensure that its adoption can be embraced through a singular platform. This will also ensure a cost-effective method going in line with one of the primary aims of the model, achieving cost savings and ensuring economic resilience and equity.

On its application, from an economic perspective, some may argue that lowering the price of air rights is not logical. However, the authors argue that this is necessary to maintain a pricing balance to prevent social and economic inequality. This possible consequence has been highlighted by numerous authors [80–82]. Moreover, the lower price of air rights, as opposed to that of surrounding suburban land, results in the encouragement of more residential units in the city center, which thereby creates more livable cities [83,84].

The time-sensitive factor is a novel approach that encourages owners to think of air rights as a leasable asset—one that is tied by agreement for use rights over a specific period of time alone. This provides another lens to view the topic and opens up new avenues for asset management. Due to the robustness and trust of platforms, new technologies such as Blockchain can be appropriate platforms to manage and track this process [85–87].

With emerging concepts, such as Smart Cities, there is increasingly the need for and invention of new models that showcase that, by economically encouraging or controlling urban planning, policies can help in urban development [88–92], and others that support Blockchain technologies can help in rendering more intelligent cities [93,94]. In addition, it can be demonstrated that the resilience and livability of cities have much to do with planning policy guidelines [90,95–97].

8. Conclusions

This paper presents a new model for the trading of air rights through transfer of development rights that respond to policies of preventing urban sprawl, hence, encouraging the preservation of fragile biodiversity on urban edges. The model narrates that Smart Contracts can render an effective method for managing transfer development rights through Blockchain technology while ensuring time-sensitive contracts. The proposed model also addresses healthy market equilibrium to negate and mediate real estate air rights speculation, which can be counterproductive for business and a deterrent for urban development. It has been shown that the application of technology can be of significant benefits, but a harmonization of protocols and standards needs to be achieved in order to ensure an efficient platform on which Smart Contracts can operate. This paper contributes to the debate on the adoption of technology for achieving increased efficiency in urban governance and management. It further offers a contribution to the debate about urban sprawl, lays the foundation for a new model to be refined by urban economists, and seeks to define the characteristics that need to be considered when designing real estate-related Blockchain networks to manage and control air rights pricing.

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