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# Exploring Potential of Public Land Based Revenues to Finance City Infrastructure: An assessment using linear programming for Guntur Municipal Corporation

**Prasanth Vardhan Puttaparthi**
School of Planning and Architecture Vijayawada, India

**Ayon Kumar Tarafdar and Abdul Razak Mohamed**
School of Planning and Architecture Vijayawada, India

## ABSTRACT

Municipalities are in search of exploring alternative own revenues to finance urban infrastructure investments in India. As compared to others, monetization of public land is within the functional domain of local governments subject to certain constraints. This study employs a linear programming model incorporating the constraints enforced by state government to assess the potentials of public lands for urban infrastructure capital investments. This approach is largely different from the existing literature, which does not determine the capacity of municipal public lands based on realized revenues. This investigation finds that certain proposed leasing strategies for Guntur Municipality under different simulations as done in this research have potentials to realize 240% more revenues compared to 'business as usual' scenario and hence, provide new policy insights for leasing public lands in a revenue optimization perspective. The framework adopted by this helps local governments to estimate the potentials of public lands and establish revenue targets.

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**Corresponding Author Contact:**

prasanth@spav.ac.in

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## 1. Introduction

Public land assets' fiscal capacities and a framework for determining the revenue potentials of existing public land assets in local self-governments have not been clearly defined in India. In recent years, the role of urban local governments in financing proposed urban infrastructure and services by exploiting their own alternative sources of revenues has been amplified by the thirteenth and fourteenth finance commissions, Government of India.and augmenting own resources to an extent of 200 percent is sought after as per the High-Power Expert Committee estimates on Indian urban infrastructure and services till 2030 (HPEC, 2011). The same committee and other studies focusing on financial sustainability of urban local governments indicate that *'Indian municipalities as weakest globally in terms of access to resources, revenue-raising capacity and fiscal autonomy'* (Mohanty, 2016) and '*improving municipal finance is central to achievement of India's economic growth objectives'* (Mathur, 2011). Realizing the challenges in bridging resource gap for infrastructure investments by local self-governments, a few studies have recommended the following options to be explored to determine the revenue potentials (Thirteenth Finance Commission, 2009; Peterson, 2009; Phatak, 2009; Mckinsey, 2010; HPEC, 2011; Mohanty, 2016; MOUD, 2017)

1. Reforms in property taxation and user/development charges
2. Value capture mechanisms
3. Debt based financing

4. Public private partnerships
5. Land based financing instruments & monetization of assets

Subsequently, the number of research initiatives, policies and documentation undertaken in view of the above recommendations are very few in India and limited to higher order cities with population of more than 1 million. However, the proposed urbanization trends in India by 2031 indicate that urban areas with less than 1 million population will account for higher share in terms of absolute increase in population and urban areas (HPEC, 2011). This shift of demographics is likely to create more pressure on provision of urban infrastructure for both economic and domestic purposes in small and medium municipalities and requires a special attention on fiscal stability. Further, the experiences on monetization of lands assets and its revenue generation capacity has drawn scholarly attention nationally and internationally in the recent past (Peterson, 2006; Sridhar & Reddy, 2009; Peterson & Kaganova, 2009; Phatak, 2013; Ballaney et al., 2013; Lin & Zhang, 2014; Patricia & Gangopadhyav, 2017, MOUD, 2017) but limited to metropolitan cities and no attempt is being made in assessing the potential of public land assets with small and medium municipalities in India. The existing revenues from public land assets, as reflected in balance sheets by local governments were considered for estimating revenue potentials of public lands (Peterson, 2006; Sridhar & Reddy, 2009). Whether these reported figures convey the revenue potentials of public lands or not, is yet to be ascertained along with various other considerations such as ownership status of public lands, regulatory constraints, and availability of marketable lands for revenue purposes, especially in small and medium municipalities of Andhra Pradesh.

More than 80% of the notified urban area is with Small and Medium municipalities in Andhra Pradesh (as on 2016), which are characterized by low to moderate population densities estimated to accommodate more than 60% of the absolute increase in population between 2011 and 2031 (arrived based on UN growth rates adopted by HPEC 2011). It is pertinent to note that the revenues realized from public lands in a financial year may be less than the demanded revenues or more (CDMA, 2014). Further, there can be difference between the demanded revenues and the potential revenues. Here, potential revenue is referred as the fair rental value of the property in case of lease, i.e., the rent that leased property can lawfully fetch if leased out to a hypothetical tenant, which can be referred from the Supreme Court decision of India in GMC vs Guntur town rate payer's association on fixation of a fair rent of any premises, reported in AIR 1971 SC 353 and AIR 353, 1971 SCR (2) 423. Internationally it was observed that municipalities have adopted to differential leasing strategies while leasing public lands with huge variations between potential value to offered/realized value, for example in China, one-on-one negotiations (*xieyi*) and auction (*paimai*) were the two main leasing approaches where the later one was recognized as the most competitive and transparent approach (Lin & Ho, 2005). However, the share of one-on-one negotiations was 86% of the total leases granted by Chinese municipalities between 1995 and 2005 (Tao et al., 2010) and authors opinion that due to the long-term tax benefits i.e., personal and business income tax, business tax and VAT, municipalities have offered land at much lower prices for industrial uses and for commercial and residential leases, the competitive approach based on market value was preferred (Lin & Ho 2005). Here potential value is determined based on the market value and with industrial uses, the indirect revenues, i.e., the long term tax revenues are considered as potential revenues. Unlike China, the central government taxes, i.e., income tax, wealth tax are not shared directly with municipalities. Transfers in the form of grants are realized but municipalities have been expected to play a key role in mobilizing financial resources for investments on their own(HPEC, 2011). Thus, it becomes essential to understand and determine the potentials of urban public land assets through a scientific approach, which helps municipalities in estimating realistic revenues (Peterson & Kaganova 2009; Sridhar & Reddy 2009) before leasing the public lands. At this juncture, this research has made a progress in determining the potentials of public land assets for Guntur Municipal Corporation, a small and medium municipality in Andhra Pradesh through revenue optimization method using linear programming model after analyzing the state of municipal finances.

In this investigation, the null hypothesis refers as "Ho: The magnitude of revenues realized from marketable public lands determines the capacity of a municipality in financing the capital investments of urban infrastructure". This investigation assumes (Ha) that leasing strategies under revenue maximization approach through liner programming model subject to constraints have higher potentials to realize revenues and can become the basis of determining the fiscal capacity as compared to standard approach, and is inherently connected to the status of public land ownership in marketable category.

## 2. Methodology

### *2.1 Description of Study Area*

As per the revised UN classification, Guntur Municipal Corporation (GMC) comes under Class IC category with 7.4 lakhs population and recorded highest growth rate of 44 % as compared between 2001 and 2011. The sudden increase in population is due to the merger of 10 peripheral villages into the GMC notified urban area. It is the third largest and fast growing city in Andhra Pradesh and serves as Administrative Headquarters of the Guntur District, and an important trade and commerce centre in the State, especially for Chillies, tobacco and turmeric commodities. The importance of Guntur as market and administrative center can be observed from the rate at which the floating population is observed, as per the city development plan of Guntur 2041, Guntur currently receives about 15,000 to 20,000 floating population from and it is projected to reach 90,000 by 2041. The average density of the erstwhile city is 142 persons per hectare (pph) and the core city densities range from 300 to 500 pph in 2011. By 2031, the city population is projected to reach 13 lakhs based on the growth rates adopted by HPEC 2011. Workers participation ratio is 37.3% in erstwhile city limits, which is very less as compared to the state and district worker's ratio of 46.6% and 48.7%

respectively in 2011. With this brief introduction, the following sections present the methodology and overview of municipal finances of GMC from 2009 to 2014 based on the data collected from CDMA, coordinating authority between the urban local bodies and the state in Andhra Pradesh, 2014, and the status of public land revenues in relation to proposed investments on urban infrastructure services 2030. All the public lands owned by GMC, leases information from 2009 to 2019, existing market values were collected from GMC and primary surveys. Every year the stamp duty and registration department of the state publishes unit rate for areas in municipalities to arrive at market value based on which the stamp duty and registration charges are fixed. The same unit values were adopted in this study for 2019.

### *2.1 Approach and Variables*

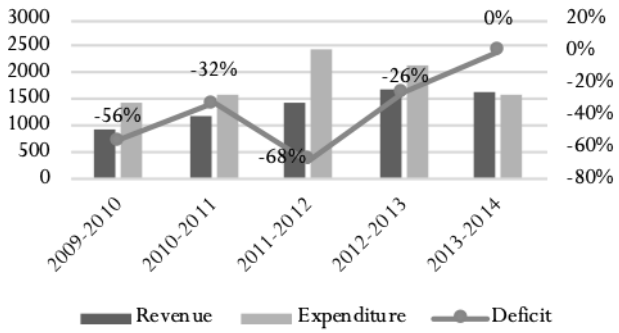
This exploratory research followed systemic approach to arrive at findings on the status of municipal finances, public land revenues, their potentials and sufficiency to finance infrastructure and services. The analytical framework adopted from literature (Roy & Johannes, 1992; Keshishishian, 2006, Mohanty, 2007; HPEC, 2011; Mathur, 2013) to assess the status of municipal finance consists of the indicators, a) fiscal gap, b) level of grants c) ratio of own revenues to expenditures, d) sufficiency of expenditures as compared to normative levels, e) share of grants in expenditures, f) property tax, and efficiency of tax revenues. Further, the potentials of public land is measured through revenue optimization approach using linear programming model along with the supporting variables, a) revenues from public lands, b) land lease revenues as proportion of GMC revenues, c) per capita revenues from land leasing, and d) utilization of proceeds from land lease (Sridhar & Reddy, 2009; Lin & Zhang, 2014). The study has adopted the normative Per-Capita Investment Cost (PCIC) 2030 determined by HPEC (2011), to estimate the proposed investments in urban infrastructure and services till 2030.

## 3. Results and Analysis

### *3.1 Municipal Finances*

Sufficiency of municipal revenues towards normative expenditures in a municipality is one of the indicators that helps in assessing the status of municipal finances (Mohanty et al., 2007; HPEC, 2011, MOUD, 2017). Figure 1 underlines that the per-capita revenues realised by GMC during the study period (2009-2014) was lower as compared to per-capita expenditures with an average revenue deficit of -36%. However, the average growth rate of own revenues was at 16% as compared to the expenditures at 10%. This indicates that there was a steady increase in the per-capita revenues realised by GMC and a detailed analysis in regard to sources of own revenues, their consistency and expenditures is presented below. The average per-capita revenue and expenditure during the assessment years were INR. 1385 and INR. 1851.

**Figure 1** Per-capita Revenue and Expenditures of GMC

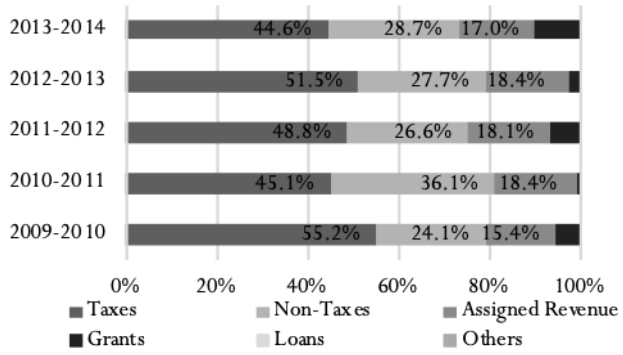



Source: CDMA, 2014

### *3.2 An Overview of GMC Revenues*

The structure of GMC revenues consists of taxes, non-taxes, transfers from higher level governments – assigned revenues, grants, loans and others. Municipal taxes and non-taxes are the two major local revenues. Figure 2 presents that the share of tax revenue was 49% of total revenues with an average growth rate of 11%, and property taxes (local revenues) account for 90% of tax revenues. As property tax being the most reliable, principle and general tax resource of municipality (GoI, 2009; Mckinsey, 2010; HPEC, 2011; Mathur, 2011), the per-capita surplus tax revenues from this source helps in determining the capacities to finance urban infrastructure. However, it was evident that municipal revenues were in deficit, the proceeds of taxes can be understood as not sufficient. The share of non-tax revenue constitutes 28.6% with an average growth rate of 26% and public land based revenues, which is the major focus of this investigation, are part of this revenue source. All the revenues realised from public lands are kept under general revenues as per the regulating rules of Andhra Pradesh and reservation towards a specific expenditure criterion is currently not practised (GMC 2019). However, scholars recommend that public land revenues/proceeds should be diverted for investments in urban infrastructure (Phatak 2013; MOUD 2017; Patricia & Gangopadhyav 2017). As compared to other sources, higher-level governments grants were relatively low at 5% but observed higher growth rates above all. During the year 2013-14, share of grants has increased to an extent of 9.8% of total revenues from 2.4% in the preceding year, which indicates higher dependency on grants. Assigned revenues from the governments account for 17.5% with an average growth rate of 20%, which is higher as compared to the overall growth rate of revenues. The major share of assigned revenues is from the stamp duty surcharges, which constitutes about 90% of the assigned revenues. Stamp duty is a charge levied on property transaction and on registration by the state and part of the revenues are shared with municipalities.

**Figure 2** Revenue Sources of GMC from 2009 to 2014

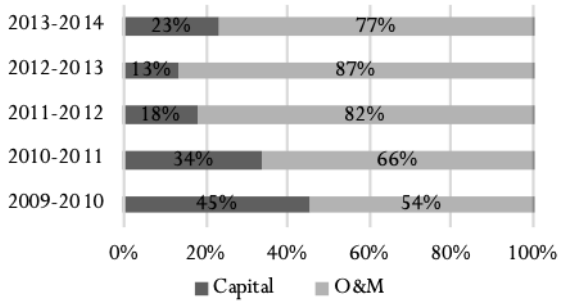



Source: CDMA, 2014

### *3.2 An Overview of GMC Expenditures*

Expenditures are classified in to Capital and Operation and Maintenance (O&M) expenditures. Salary and allowances of staff working for GMC, administrative expenses, maintenance of infrastructure and services, etc., are part of O&M expenditures and others related to creation of assets, construction of roads, water supply installations, etc., are part of capital expenditures. Figure 3, highlights that 78% of the overall expenditure is on O&M with an average growth rate of 24% during 2009-14. It was observed that non-tax revenues growth rate of 26% was relatively better among others revenues and the efficiency of growth rate of non-tax revenues to O&M expenditures during the study period was at 1.08, which indicates a positive scenario. However, a closer investigation on per-capita revenues over expenditure reveal that, non-tax revenues were able to recover only 30% of O&M expenditures and the sufficiency of own revenues (including taxes and non-tax) to the total expenditures was only 59%. Studies on municipal finances have indicated that Indian municipalities spend very less on infrastructure services as compared to normative expenditures levels with poor O&M collection efficiency (HPEC, 2011). The analysis on Guntur reveal that the underspending was high at 70% during the study period and recovery levels were at less than 20% as compared to the existing levels of 30%. Therefore, it can be understood that the revenues realised by GMC were not sufficient to the present expenditure levels and also when compared to normative levels. The fiscal condition of municipality is likely to further deteriorate due to the existing gap between the per-capita expenditures to own revenues.

**Figure 3** Expenditures of GMC from 2009 to 2014




Source: CDMA, 2014

### *3.3 Estimates on Urban Infrastructure Investments*

To arrive at estimates for urban infrastructure investments in Guntur Municipal Corporation (GMC), normative Per-Capita Investment Cost (PCIC) 2031 determined by HPEC, 2011 were adopted in this investigation. These capital investments cover eight sectors of physical infrastructure and to assess fiscal capacity of GMC at regular intervals in relation to investments required, the estimates have been arrived for three time periods, i.e., 2020, 2025 and 2030 on the basis of relative share of absolute change in population. As the base year estimates of HPEC is for 2011, Consumer Price Index – India (CPI) from 2009 to 2019 was used to arrive at PCIC for 2019-20 and for the later investment years, an inflation of 4% per annum was assumed. From the estimates arrived, presented in table 1, it's evident that a total of 50.4% of the investment required for urban infrastructure services during the study period (2019 to 2031) is required by 2020. The subsequent investment years demand relatively a minor share of 8.4% in 2025 and 11.2% in 2030 of the total investments. Further, it is assumed that 30% of remaining investments are committed investments till 2019 by GMC, arrived based on the budget accounts of preceding years to 2020. To finance the proposed capital investments of INR.441 crores in 2020, the potentials of public lands have been assessed as a part of this research.

**Table 1** Estimates for Urban Infrastructure Investments in GMC

| Year | Population | Per Capita Investment Cost (INR.) | Investment Required (in crore) |
|---|---|---|---|
| 2019 | 952547 | 84092 | 252.9 |
| 2020 | 994029 | 87456 | 441.1 |
| 2025 | 1097382 | 106404 | 89.0 |
| 2030 | 1211480 | 129456 | 144.9 |

Source: Authors calculations

### *3.3 Ownership Status Of Public Land Assets*

Public land is a multidimensional resource and commodification of public land to finance urban infrastructure investments is one among the resource options practiced by local governments, and as compared to other revenue sources, this revenue stream has freedom and offers flexibility to local self-governments (Peterson, 2009). Authors argue that urban land in India is yet to be exploited as fiscal resource to finance urban infrastructure developments (Mohanty, 2014) and urban public land is underutilized from fiscal perspectives (Patricia and Gangopadhyav, 2017). Few authors claim that monetization of public lands allow the municipalities to capture future land value increments and become an important source of revenues (Yeh, 1994; Farvacque & McAuslan, 1992; Archer). Further it can be assumed that the magnitude of revenues realized from public lands rely on the status of public land ownership under marketable category (Lin & Zhang 2014; Liu 2018) and the efficiency of municipality in monetizing. In this connection, first an assessment is carried out to understand the current status of public land ownership by category in Guntur along with regulating constraints on leasing.

A total of 184 hectares of public land belong to GMC as on 2019, excluding the area under water works and transportation. This land is distributed in 277 plots of various land uses within the notified area of municipality, and are of freehold ownership. For the purpose of this research, all these lands were classified in to three groups while determining revenue potentials, i.e., marketable properties, marketable restricted properties and non-marketable properties. All the marketable properties are free from any restrictions and can be leased out for such land uses permitted in the regulating master plan, by fulfilling the conditions set by state governments on leases whereas marketable restricted properties have limited possibilities of using them for revenue maximization. The non-marketable properties cater the social needs of society, i.e., parks, playgrounds, schools, primary health care center, burial grounds and others where change of use or revenue maximization strategies cannot be imposed.

Table 2 presents the existing status and distribution of public lands by category in GMC. It is evident that very limited amount of land is under marketable category with an extent of 13% of total public land and there has been no increase in ownership status of marketable land in the last 30 years. This signifies that the regulating statutory plans, land management approaches and development projects in GMC have not been able to generate or build additional marketable land bank during the last 30 years. Further, 56% of the public land is under non-marketable followed by 31 % in marketable restricted category. Under marketable restricted category, a few of the vacant lands obtained by GMC through planning instruments as layout open spaces are to be utilized only for creation of open spaces. Close to 90% of vacant land are part of layout open spaces and the remaining vacant lands can be leased out while complying the regulating rules enforced by higher Governments. The conditions, referred as rules in this investigation are related to lease of public lands, reservations of properties, fixation of user charges in markets and etc., are discussed below.

**Table 2** Public Land Assets of Guntur Municipal Corporation

| | Type | | No of Plots | Area (sq.m) |
|---|---|---|---|---|
| A | Marketable | | | |
| 1 | Lands Leased | (L) | 8 | 16963 |
| 2 | Markets | (M) | 6 | 19029 |
| 3 | Shopping Complexes | (SC) | 20 | 16659 |
| 4 | Others | (O) | 1 | 5760 |
| B | Marketable Restricted | | | |
| 5 | Municipal Buildings | (Q) | 9 | 16797 |
| 6 | Community Halls | (C) | 4 | 4385 |
| 7 | Urban Health Centre | (U) | 10 | 5000 |
| 8 | Vacant Lands | (VC) | 67 | 267478 |
| C | Non-Marketable | | | |
| 9 | Burial Grounds | (B) | 12 | 112639 |
| 10 | Parks & Play Grounds | (P) | 9 | 196091 |
| 11 | Reservoir | (R) | 17 | 559790 |
| 12 | Sanitary Offices | (S) | 9 | 3055.45 |
| 13 | School Buildings | (SB) | 94 | 160596 |
| 14 | Dumping Yards | (D) | 6 | 457735 |
| 15 | Libraries & Others | (LB) | 4 | 2129 |

Source: GMC, 2019

### *3.3 Reservation of public land leases*

When municipal governments in the State of Andhra Pradesh intent to award a lease, or enter into a lease agreement on public lands, fix the lease value of the property, etc., the following set of rules and regulations enacted by State Government have to be confirmed by municipality.

**a. Fees from lands,** the right to collect fees in respect of public land used for markets within the municipal jurisdiction is entrusted to municipality. The competent authority shall approve the conditions and terms, and enter into a contract with the lessee as per the section 43 of AP municipality Act. *"All the leases are to be executed through public auction".*

**b. Fixation of Rent**, as per the G.O.Ms.No.56 dated 05-02-2011, the amendment to AP Municipalities (regulation of receipts and expenditures) states that the commissioner through preliminary notice will set the terms and conditions subject to which the lease of immovable properties is granted. The following are advised for fixing the upset price of the lease.

- *Rent at 10% of the current market value of the property per annum (both building and land) market value of land and construction rates of the structures and buildings fixed by registration department*
- *Prevailing rent of such properties situated in the vicinity whichever is higher in case of lease of immovable properties for the first time*
- *Renewal of lease, either by 1 or 2 or rent at 33. 1/3 percent rent above the earlier rent (higher)*

**c. Reservation of Shops for SC and ST community members and 50 percent concession**, as per the G.O.Ms.No. 253 dated 02-04-1993 and G.O.Ms.No. 178 dated 23.04.2010 of Government of Andhra Pradesh, the government by order stated that 15% of the shops and stalls constructed by municipality to be leased out to members of the Scheduled Caste (SC) community on payment of market rate or rent paid by the neighboring shops without the public auction. Subsequent orders states that the rent of such shops to be fixed at INR. 2.5 per square feet or 50 percent of the rent paid by neighboring shops whichever is less. In same respect, Government orders have reserved 6% of shops for Scheduled Tribe (ST) community members on payment basis of INR. 2.5 per square foot or 50 percent of the fare paid by neighboring shop rooms whichever is less without public auction.

**d. Reservation of Shops for AP Nayee Brahmana Seva Sangham**, G.O.Ms.No. 116 MA dated 01-02-2008 by order stated to reserve 5 % of shops and stalls constructed by the municipalities under various schemes including good will auction to be leased out by conducting public auction among the Nayee Brahmin and washer men co-operative

societies without public auction under the provisions of AP Municipalities.

e. **Lease Duration,** it is observed that as per the regulation of receipts and expenditure rules, 1968 and G.O.Ms.No.120, dated 31-03-2011, GMC has the powers *"to renew the lease for a period of not exceeding three years at a time and with the approval of state government exceeding three years".* However, the municipality can renew the lease not exceeding twenty-five years of a particular property without conducting public auction subject to *"willingness of the lessee for 33 1/3 percent increases in lease value to the earlier rent or the prevailing market value of such shops satiated in the vicinity, whichever is higher".*

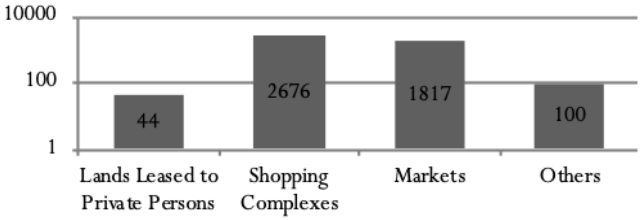
Based on the above set of rules, it is inferred that "rent", which is a key determinant of revenue potential of public lands is fixed based on the prevailing market rental value or 10% of the current market value of the property per annum or 33 1/3 rent above the earlier rent of such plots, whichever is higher. Further, it was observed from the data and discussions held with officials that the process of revising rental values by municipality doesn't happen periodically and due to which, there are variations observed between the actual market rental values to demanded amount. Therefore, the demanded amounts from leases don't determine the actual capacity of the public lands. All public leases in GMC, except the reservations are leased through public auction with less than 5 years of lease term, which is inferred as an effective mode of lease mechanism (Pan et al., 2016). The following section discusses the trends of public land based revenues realized by GMC based on the data sets collected from CDMA for the years 2009 to 2014. There are more than 800 leases granted by GMC annually and data is compiled plot and category wise to arrive at inferences.

## *4 Per-capita Public Land Revenues (2009-14)*

Among all the public land leases, revenues realized from shopping complexes and markets stands highest with an annual growth rate of 22% and 85%. The occupancy of these leases reported was 100% as GMC being a trade center for agriculture and allied activities, demand for markets and commercial land uses is higher (CDP 2014). It was observed that the tenants deposit rents in three possible options, i.e., a) regular installments on monthly basis, b) advance payment for the complete lease duration, i.e., for 3 years and c) late payment with penalty charges at the time of renewal and this has resulted variations in realized revenues and reason for higher growth rates. The revenues realized during the study period 2009-14 had capacity to finance 8% of the capital investments of GMC, which is relative low as compared to cities in China (Lin & Zhang, 2014). The revenues presented here was based on net payments received by GMC but not on the demanded amounts. Studies carried out in this field have referred to revenues realized as the fiscal capacities (Peterson, 2009; Peterson, 2006; Sridhar & Reddy, 2009) but not on the basis of demanded revenues or potential value. Authors opinion that demanded revenues based on the potential value may indicate the actual capacity (Patricia & Gangopadhyay, 2017 and an assessment in this regard is presented below.

### *4.1 Per-capita Land Revenues Demanded*

**Figure 4** Annual average revenues from marketable public land in GMC per sq.m (2009 – 2019)



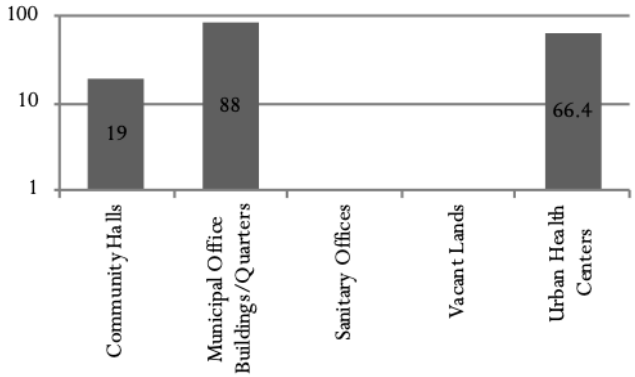

Source: GMC, 2019

Among all the marketable lands, the average lease amount demanded in shopping complex was INR. 2676 per sq.m followed by markets, others and lands leased categories (figure 4). There were 27 properties of different sizes under shopping complex category located in various parts of the city and the variation within this category on revenues demanded vary from INR. 18 per sq.m to 4859 per sq.m per year. It was observed that plots of same use located in close proximity have varied rental values demanded. Similarly, there were 6 markets located having more than 500 shops leased out had the average demanded amount of ranging from INR. 427 per sq.m to INR.3368 per sq.m. The other leases also recorded variations with in the category and over other categories (Figure 5). Further, the analysis on plot area utilization ratio, assessed by comparing the potential rental area (including built up area) of the plot to existing leased area highlights that close to 30% of the properties have additional permissible area, which can fetch more revenues, if leased but involves development costs to GMC.

Based on the discussions held with municipal officials and from the data analyzed, it is inferred that public lands located within close proximity to each other with same land market value have varied demanded rental values due to the extent of reservations offered, and the net revenue area leased. Here net revenue area refers to the built up area made available for lease in a given plot. Besides, there is no regulatory compulsion or requirement on reserving lands for commercial, markets or shopping complexes, and municipalities are free to decide upon the land use to which the marketable lands can be leased with or without development. Therefore, it can be assumed that existing public lands of GMC under marketable category may fetch higher revenues, if the plots are fully developed and leased to its optimum use from the revenue maximization perspective. This approach might require GMC to obtain loans from market and compare the revenues over project life cycle to arrive at Net Present Value (NPV) and determine the overall financial feasibility and compare the results to existing revenues. There has been no assessment carried by GMC in this regard while leasing the public land and leaves an opportunity for this research to examine the potentials through linear programming. Overall, it is clear to note from the above that demanded revenues or realized revenues, existing use of public land and current lease area of the plot may not indicate the actual fiscal capacity of public lands, and there is a need to develop a

comprehensive framework to ascertain the potentials of public lands, which can become the base for GMC to establish revenue targets from public lands and also to ascertain the fiscal capacities. Further, to identify the other control variables that influence the rental values, a correlation and regression analysis is carried and the results are discussed below.

**Figure 5** Annual average revenues from marketable restricted public land in GMC per sq.m (2009 – 2019)




Source: GMC, 2019

### *4.2 Correlation and Regression Analysis*

Based on the variables identified through expert's opinion survey, a correlation and regression analysis was carried out to understand statistical relationship and significance of rental value demanded for all the leases awarded between 2008 and 2019. The rental value demanded per sq.m of public lands was considered as the dependent variable and the independent variables were plot size, distance from CBD, plot shape & use, abutting road width, permissible FSI, no. of shops, in case of markets and shopping complex, market value and net revenue area of each plot. Through analysis, it is understood that none of these variables have statistical significance and the coefficient of determination was very low with higher variance. Outliers within the data sets were then identified using SPSS software and carried out multiple linear regression using step wise approach method. Among all the variables, net revenue area of each plot has 0.759** and market value has 0.739** correlation significant at 0.01 level (2-talied). Other variables have shown very low significance with higher variations. From the above, it is significant to note that higher the market value and availability of rental area, including the built-up area of a plot determine the potential rental value of the public land, and confirms to the inference presented earlier.

Therefore, this research presumes herein that it is essential to consider the following aspects while estimating the potential of public lands: *a) existing rental and potential value, b) permissible developable area c) reservations on leases d) time period of lease e) revision of rental values f) development costs and net present value of future revenues from leases*. Considering all the above, an attempt has been made to assess the revenue potentials of public lands for GMC through revenue maximization approach using linear programming model, which is presented below in detail.

## 5. Application of Linear Programming

Linear Programming, an optimization technique (Taha, 1999; Srinivasan, 2010) is employed to arrive at the potentials of the existing public land assets in GMC subject to constraints. Here constraints refer to all the government reservations on leases, rental values, revision of rental values and reservation of lands for other purposes. By satisfying the conditions set by governments on reservation of lands, this research has formulated four scenarios to ascertain the potentials of public lands. In all scenarios, the revenue strength of public lands is assessed based on the net rental value of future cash flows for different time periods, i.e., 10 years, 15 years, 20 years, 25 years, 30 years, 35 years, 40 years and 50 years. Net rental value was arrived after subtracting the administrative expenditures of municipality and the reservations, which account for 26% of the total leases in markets and shopping complexes at 50% actual rental value. This has been arrived to check the revenue capacities of GMC at regular intervals and to determine the time period, number of years for which public land revenues need to be reserved towards estimated capital investments. As per the regulating government orders, the rate of increase in rental values of 33 and 1/3 % once in three years is considered as the rental inflation value in discounting cash flow analysis. Development costs of plots were arrived through Central Public Works Department costs determined on per sq.m basis and inflation of costs during the time period (2020 – 2060) was assumed as 4.5%. The formulation of linear program problem in scenarios developed followed the standard approach, i.e., identification of decision variables, ascertain the objective function, incorporating the constraints, defining the non-negative variables. Through GRC non-linear method by incorporating all the constraints, the optimum results are arrived and the details of each scenario are presented below.

### *5.1 Scenario 1, Business-As-Usual-Scenario*

The basic objective of this scenario was to construct the existing model of public land leases (without any change) and determine the revenue capacities of public lands in financing the estimated infrastructure investments of GMC using discounted cash flow analysis. Once the optimal solution was arrived for the base year, i.e., 2019, the revision of rental values and development costs during the assessment years were incorporated based on the historical trend analysis for determining the revenue strengths of public lands. In business as-usual scenario, the objective function is to maximize the revenues from public lands subject to constraints. As this scenario being the base model, the existing revenue area of public lands (in 2019) in marketable category was considered as the maximum area available for lease till the property reaches its obsolescence year, and no additional development costs were considered in the base year. When the buildings reach to its obsolescence year, re-development of the plots to its permissible capacity was permitted in the model and subsequently the development costs were included in the discounted cash flow analysis to arrive at NPV of future revenues. As discussed earlier, the development costs were arrived through CPWD rates (2019), and an inflation of 4.5 % annually on costs was assumed during the assessment years, i.e.,

from 2020 to 2060. Based on the historical trend observation method, preferred option by GMC for mobilising capital resources through bank loans with 12% Rate of Interest (RoI) and 10 years payback period post construction activity were considered in the analysis. Though there was more potential revenue area available within the plot for further leasing, the existing revenue area of each plot was considered as the maximum revenue area in the base model. The details of the decision variables, objective functions, constraints, non-negative variables.

Decision Variable – Revenues from public land leases (Z)
Objective Function –

$$Z = x_B + x_C + x_D + x_L + x_{LB} + x_M + x_Q + x_O + x_P + x_R + x_S + x_{SB} + x_{SC} + x_U + x_{VC}$$

$$Z = \sum_{rb=1}^{12} x_{rb} + \sum_{rc=1}^{4} x_{rc} + \sum_{rd=1}^{6} x_{rd} + \sum_{rl=1}^{8} xr_l + \sum_{rlb=1}^{4} x_{rlb} + \sum_{rm=1}^{6} x_{rm} + \sum_{rq=1}^{9} x_{rq} + \sum_{ro=1}^{1} x_{ro} + \sum_{rp=1}^{9} x_{rp} + \sum_{rr=1}^{17} x_{rr} + \sum_{rsb=1}^{94} x_{rsb} + \sum_{rsc=1}^{20} x_{rsc} + \sum_{ru=1}^{1} x_{ru} + \sum_{rvc=1}^{4} x_{rvc}$$

r = Net existing rental value of the plot per sq.m;
xrb…rn= net revenue from each category of plots,
refer table 2 for categories

**a. Shopping Complex**

$$x_{SC} = \sum_{rsc=1}^{20} x_{rsc}$$

$x_{SC}$ = 10671 (Area under revenue category in base year) ……1

$Dx_{SC} = 0$ (Base Year) ……2

*D=Development cost per sq.m*

$x_{rSC} = r_1 \times sc_1 + r_2 \times sc_2 + \ldots\ldots\ldots\ldots + r_{20} \times sc_{20}$

*sc = existing revenue area of the plot in sq.m*

**b. Markets**

$$x_M = \sum_{rm=1}^{6} x_{rm}$$

$x_M = 11036$ *(Area under revenue category in base year)* ……3

$Dx_M = 0$ *(Base Year)* ……4

$x_{rm} = r_1 \times m_1 + r_2 \times m_2 + \ldots\ldots\ldots\ldots + r_6 \times m_6$

*m = Net revenue area of the plot in sq.m*

**c. Municipal Office Buildings/Quarters**

$$x_Q = \sum_{rq=1}^{9} x_{rq}$$

$X_Q = 7836$ *(Area under revenue category in base year)* ……5

$Dx_Q = 0$ *(Base Year)* ……6

$x_{rq} = r_1 \times q_1 + r_2 \times q_2 + \ldots\ldots\ldots\ldots + r_9 \times q_9$

*q = Net revenue area of the plot in sq.m;*

**d. Land Lease**

$$x_L = \sum_{rl=1}^{8} x_{rl}$$

$x_L = 16484$ *(Area under revenue category in base year)* ……7

$Dx_M = 0$ *(Base Year)* ……8

$x_{rl} = r_1 \times l_1 + r_2 \times l_2 + \ldots\ldots\ldots\ldots + r_9 \times l_9$

*l = Net revenue area of the plot in sq.m*

**e. Vacant Land**

$$x_{VC} = \sum_{rvc=1}^{4} x_{vc}$$

$x_L = 4114$ *(Area under Revenue Category in base year)* ……9

$Dx_M = 0$ *(Base Year)* ……10

$x_{rvc} = r_1 \times vc_1 + r_2 \times vc_2 + \ldots\ldots\ldots\ldots + r_9 \times vc_9$

*vc = Net revenue area of the plot in sq.m;*

**f. Others**

$$x_O = \sum_{ro=1}^{1} x_{ro}$$

$x_L = 4320$ *(Area under revenue category in base year)* ……11

$Dx_M = 0$ *(Base Year)* ……12

$x_{ro} = r_1 \times o_1$

*o = Net revenue area of the plot in sq.m;*

$x_n > 0$……13

| | | | |
|---|---|---|---|
| $\sum_{rb=1}^{n} x_{rb} = 0.001 \times r_n$ | (Revenue) | …14 | Burial Grounds |
| $\sum_{b=1}^{n} x_b = 112639$ | (Area) | …15 | |
| $\sum_{rc=1}^{n} x_{rc} = 4385 \times r_n$ | (Revenue) | …16 | Community Halls |
| $\sum_{c=1}^{n} x_{]c} = 4385$ | (Area) | …17 | |
| $\sum_{rd=1}^{n} x_{rd} = 0.001 \times r_n$ | (Revenue) | …18 | Dumping Yards |
| $\sum_{d=1}^{n} x_d = 457735$ | (Area) | …19 | |
| $\sum_{rd=1}^{n} x_{rlb} = 0.001 \times r_n$ | (Revenue) | …20 | Libraries & Reading Rooms |
| $\sum_{lb=1}^{n} x_{lb} = 2129$ | (Area) | …21 | |
| $\sum_{rp=1}^{n} x_{rp} = 0.001 \times r_n$ | (Revenue) | …22 | Parks & Play Grounds |
| $\sum_{p=1}^{n} x_{lb} = 196091$ | (Area) | …23 | |
| $\sum_{rr=1}^{n} x_{rr} = 0.001 \times r_n$ | (Revenue) | …24 | Reservoir |
| $\sum_{r=1}^{n} x_r = 559789$ | (Area) | …25 | |
| $\sum_{rs=1}^{n} x_{rs} = 0.001 \times r_n$ | (Revenue) | …26 | Sanitary Offices |
| $\sum_{s=1}^{n} x_s = 3055$ | (Area) | …27 | |
| $\sum_{rsb=1}^{n} x_{rsb} = 0.001 \times r_n$ | (Revenue) | …28 | |
| $\sum_{sb=1}^{n} x_{sb} = 160596$ | (Area) | …29 | |
| $\sum_{ru=1}^{n} x_{ru} = 5000 \times r_n$ | (Revenue) | …30 | Urban Health Center |

Equations from 14 to 30 refer to all the reservation of lands of restricted category, where the change of use, area and revenue was not permitted.

***Results of Business As Usual Scenario***

| Time Period | Years | NPV 2019 (Crores) |
|---|---|---|
| 2020-2029 | 10 | ₹53 |
| 2020-2034 | 15 | ₹81 |
| 2020-2039 | 20 | ₹105 |
| 2020-2044 | 25 | ₹125 |
| 2020-2049 | 30 | ₹142 |
| 2020-2054 | 35 | ₹156 |
| 2020-2059 | 40 | ₹166 |
| 2020-2069 | 50 | ₹186 |

The total investments required by 2020, as per the estimates was INR.441 crores and from the above results, it is evident that GMC has the capacity to finance 42.15% of the capital investments required for urban infrastructure in GMC 2020, if the revenues from public land leases are reserved for 50 years towards capital investments for urban infrastructure. The fiscal capacity of GMC can further improve in business as usual scenario, if the debt is made available by governments at reduce rate of interest.

## *5.2 Scenario 2, Revenue Optimization By Utilizing The Maximum Developable Area Within The Plot And Change Of Land Use In Few Categories*

The overall objective of this scenario was to maximize the revenues from public lands by allowing the model to change the land use of plots in marketable category based on potential rental values and to maximize the revenue area within the plots. Unlike the business as usual scenario, the existing land use of each plot under marketable category was permitted to change for revenue maximization in this model with least development costs as a criterion, except markets and shopping complexes. Besides, the potential revenue area with in the plot was compared to the existing revenue area, and the difference in area was assumed for development and lease in this scenario. For each category of land use, the revenue optimization through linear programming by utilizing the maximum developable area within the plot and conversion of land use plot wise was carried out while reserving the non-marketable and marketable restricted category land uses in this scenario. The major objectives of revenue optimization of each category of public lands employed in this approach are as follows.

1. *Shopping Complex (Maximization of revenue area)*
2. *Markets (Maximization of revenue area)*
3. *Vacant Lands (Conversion of land use from vacant land to land lease)*
4. *Land Lease (Revision of rental value based on the market value 2019)*
5. *Municipal Buildings & Quarters (Maximization of revenue area)*
6. *Others (Conversion of Land use from others to land lease)*

Among all the categories, conversion of use from vacant lands, others to land lease was least development cost approach to municipality, where the costs of development are very less.

Objective Function Overall – Revenue Optimization by utilizing the developable area

$$Z = x_B + x_C + x_D + x_L + x_{LB} + x_M + x_Q + x_O + x_P + x_R + x_S + x_{SB} + x_{SC} + x_U + x_{VC}$$

**a. Shopping Complex**

$$X_{SC} = \sum_{sc=1}^{20} rx_{sc}$$

Objective Function & constraints

$$X_{SC} = 2526(SC_{r1}) + 4001(SC_{r2}) + 4096(SC_{r3}) + 1354(SC_{r4}) + 1589(SC_{r5}) + 2702(SC_{r6}) + 23(SC_{r7}) + 3945(SC_{r8}) + 1657(SC_{r9}) + 1911(SC_{r10}) + 1155(SC_{r11}) + 3438(SC_{r12}) + 3243(SC_{r13}) + 1150(SC_{r14}) + 414(SC_{r15}) + 1664(SC_{r16}) + 2514(SC_{r17}) + 547(SC_{r18}) + 2728(SC_{r19}) + 3103(SC_{r20}) \quad \ldots\ldots\ldots\ldots\ldots 1$$

$$\sum_{sc=1}^{20} x_{sc} \leq 22455 \text{ (Maxmium Area under revenue category)} \quad \ldots\ldots\ldots\ldots\ldots 2$$

$$sc_n = sc_{rn};\ rn = \text{maximum net revenue area of each plot}$$

$$x_{sc1} + x_{sc2} + x_{sc3} + x_{sc4} + x_{sc5} + \ldots\ldots\ldots + x_{scn}\ 0\ (DevelopmentCost) \quad \ldots\ldots\ldots\ldots\ldots 3$$

**b. Markets**

$$x_M = \sum_{rm=1}^{6} x_{rm}$$

$$X_M = 14658 \text{ (Maximum Area under Revenue Category)} \quad \ldots\ldots\ldots\ldots\ldots 4$$

$$x_{rm} = 585(m_{r1}) + 2194(m_{r2}) + 1911(m_{r3}) + 12066(m_{r4}) + 1405(m_{r5}) + 5330(m_{r6}) \quad \ldots\ldots\ldots\ldots\ldots 5$$

$$m_n = m_{rn};\ rn = \text{maximum net revenue area of each plot}$$

**c. Vacant Land**

$$x_{VL} = \sum_{vml=1}^{n} rx_{vml} + \sum_{vmm=1}^{n} rx_{vmm} + \sum_{vmsc=1}^{n} rx_{vmsc} + \sum_{vmq=1}^{n} rx_{vmq} + \sum_{vmo=1}^{n} rx_{vmo}$$

$$x_{VL} \leq 6171 \text{ (Maximum Area under Revenue Category)} \quad \ldots\ldots\ldots 6$$

$$vl_n = vl_{rn}$$

*rn= maximum net revenue area of each plot*

*vml =plots converted from vacant land category to land lease category; vmm = plots converted to markets category; vmsc = plots converted to shopping complex; vmq = plots converted to quarters; vmq= plots converted to other.*

**d. Municipal Office Buildings/Quarters**

$$X_Q = \sum_{rq=1}^{8} x_{rq}$$

$$x_{rq} = -12(q_{r1}) + 1200(q_{r2}) - 12(q_{r3}) + 1500(q_{r4}) - 12(q_{r5}) + 44(q_{r6}) + 500(q_{r7}) + 33(q_{r8}) \quad \ldots\ldots\ldots\ldots\ldots 7$$

$$X_Q = 14679 \text{(Maximum Area under Revenue Category)} \quad \ldots\ldots\ldots\ldots\ldots 8$$

$$q_n = q_{rn}$$

rn= maximum net revenue area of each plot

Some of the plots under municipal buildings and Quarters have no revenues realised and regular expenditures towards the O&M and administrative expenses result in deficits.

**e. Land Lease**

$$X_L = \sum_{rl=1}^{7} x_{rl}$$

$$x_{rl} = 588(l_{r1}) + 588(l_{r2}) + 1578(l_{r3}) + 1188(l_{r4}) + 2088(l_{r5}) + 588(l_{r6}) + 588(l_{r7}) \quad \ldots\ldots\ldots\ldots\ldots 9$$

$$X_L = 16484.2 \text{(Maximum Area under Revenue Category)} \quad \ldots\ldots\ldots\ldots\ldots 10$$

$$x_{rl} = r_1 \times l_1 + r_2 \times l_2 + \ldots\ldots\ldots\ldots + r_9 \times l_9$$

l = Net revenue area of the plot in sq.m;

**f. Others**

$$X_O = \sum_{ro=1}^{1} x_{r0}$$

$$x_{ro} = 2088(X_o) \quad \ldots\ldots\ldots\ldots\ldots 11$$

$$X_o = 5760 \text{ (Maximum Area under Revenue Category)} \quad \ldots\ldots\ldots\ldots\ldots 12$$

***Other constraints and Assumptions,*** Equations from 14 to 30, of Scenario 1 refer to all the reservation of lands of restricted category, remains same in Scenario 2.

***Results of Scenario 2***

| Time Period | Years | NPV 2019 (Crores) |
|---|---|---|
| 2020-2029 | 10 | ₹41 |
| 2020-2034 | 15 | ₹78 |
| 2020-2039 | 20 | ₹113 |
| 2020-2044 | 25 | ₹145 |
| 2020-2049 | 30 | ₹173 |
| 2020-2054 | 35 | ₹198 |
| 2020-2059 | 40 | ₹223 |
| 2020-2069 | 50 | ₹264 |

With few changes to scenario 1, the fiscal capacity of GMC in revenue optimization approach of scenario 2 has increased to INR. 264 crores and able to finance near about 60% of total investments required by 2020 based on the NPV of future cash flows in base year. Form the above results, it is evident that by undertaking the developments from base year onwards in those plots where more buildable area was permissible in conjunction with building bylaws and by revising the rental values based on the proposed land use, the revenue strengths of GMC has increased by 44% as compared to scenario 1. This has been achieved while reserving public lands for non-marketable land uses and marketable restricted as observed in base year 2019. As the development costs were more during the initial years, the revenue potentials of this scenario in long term fetch better revenues when compared with scenario 1.

### *5.3 Scenario 3, Revenue Optimization through Revision Of Rental Values*

In this scenario, the revision of rental values based on market values arrived through unit cost method or prevailing rental values of neighbouring plots or 33.1/3% of the existing rental values, whichever is higher was considered and assessed the revenue potentials. Conversion of use other land uses with moderate development costs based on the revenue potentials along with revision of rental values was allowed in this scenario and the details are as given below:

1. Shopping Complex (Revision of rental values on Scenario 2)
2. Markets (Revision of rental values on Scenario 2)
3. Vacant Lands (Conversion of land use to land lease and revision of rental value)
4. Land Lease (Conversion of use to shopping complex and revision of rental value)
5. Municipal Buildings & Quarters (Conversion of land use to other land uses)
6. Others (Conversion of Land use from Others to shopping complex)
7. Objective Function Overall – Revenue Optimization by utilizing the developable area

$$Z = x_B + x_C + x_D + x_L + x_{LB} + x_M + x_Q + x_O + x_P + x_R + x_S + x_{SB} + x_{SC} + x_U + x_{VC}$$

**a. Shopping Complex**

$$X_{SC} = \sum_{sc=1}^{20} rx_{sc}$$

**Objective Function and constraints**

$$X_{SC} = 2526(SC_{r1}) + 4001(SC_{r2}) + 4096(SC_{r3}) + 1354(SC_{r4}) + 1589(SC_{r5}) + 4620(SC_{r6}) + 1588(SC_{r7}) + 3945(SC_{r8}) + 2088(SC_{r9}) + 1911(SC_{r10}) + 1788(SC_{r11}) + 3438(SC_{r12}) + 3330(SC_{r13}) + 2238(SC_{r14}) + 4389(SC_{r15}) + 2430(SC_{r16}) + 5620(SC_{r17}) + 1709(SC_{r18}) + 2891(SC_{r19}) + 3246(SC_{r20})$$

$\sum_{sc=1}^{20} x_{sc} \leq 22455$ (Maxmium Area under revenue category).....1

$sc_n = sc_{rn}$

*rn= maximum net revenue area of each plot, 10% of the total market value of the plot or the prevailing rental value of the plot, whichever is higher.*

$x_{sc1} + x_{sc2} + x_{sc3} + x_{sc4} + x_{sc5} + \ldots\ldots\ldots + x_{scn} \geq 0$ $(DevelopmentCost)$.....2

**b. Markets**

$$x_M = \sum_{rm=1}^{6} x_{rm}$$

$X_M = 14658$ *(Maximum Area under Revenue Category)* .....3

$x_{rm} = 1938(m_{r1}) + 2194(m_{r2}) + 1911(m_{r3}) + 12066(m_{r4}) + 1938(m_{r5}) + 5330(m_{r6})$

$m_n = m_{rn}$

*rn= maximum net revenue area of each plot, 10% of the total market value of the plot or the prevailing rental value of the plot, whichever is higher.*

**c. Vacant Land**

Conversion of Land use from Vacant Land to Land Lease

$$x_{VL} = \sum_{vml=1}^{n} rx_{vml}$$

$X_{VL} = 2288(vl_{r1}) + 2088(vl_{r2}) + 1788(vl_{r3}) + 1588(vl_{r4})$

$x_{VL} = 4114$ *(Maximum Area under Revenue Category)* .....4

$vl_n = vl_{rn}$

*rn= maximum net revenue area of each plot*

**d. Municipal Office Buildings/Quarters**

$$X_Q = \sum_{rq=1}^{8} x_{rq}$$

$x_{rq} = -12(q_{r1}) + 1200(q_{r2}) - 12(q_{r3}) + 1500(q_{r4} - 12(q_{r5}) + 44(q_{r6}) + 500(q_{r7}) + 33(q_{r8})$

$X_Q = 14679(Maximum\ Area\ under\ Revenue\ Category)$ .....5

$q_n = q_{rn}$

*rn= maximum net revenue area of each plot*

**e. Land Lease**

$$X_L = \sum_{rl=1}^{7} x_{rl}$$

$x_{rl} = 588(l_{r1}) + 588(l_{r2}) + 1578(l_{r3}) + 1188(l_{r4}) + 2088(l_{r5}) + 588(l_{r6}) + 588(l_{r7})$

$X_L = 16484.2(Maximum\ Area\ under\ Revenue\ Category)$ .....6

$x_{rl} = r_1 \times l_1 + r_2 \times l_2 + \ldots\ldots\ldots\ldots + r_9 \times l_9$

**f. Others**

$$X_O = \sum_{ro=1}^{1} x_{r0}$$

*Leasing of the land based on the market value of the plot*

$x_{ro} = 2088(X_o)$.....7

$X_o = 5760\ (Maximum\ Area\ under\ Revenue\ Category)$ .....8

***Other constraints and Assumptions,*** Equations from 14 to 30, of Scenario 1 refer to all the reservation of lands of restricted category, remains same in Scenario 3.

### *Results of Scenario 3*

| Time Period | Years | NPV 2019 (Crores) |
|---|---|---|
| 2020-2029 | 10 | ₹41 |
| 2020-2034 | 15 | ₹99 |
| 2020-2039 | 20 | ₹152 |
| 2020-2044 | 25 | ₹202 |
| 2020-2049 | 30 | ₹247 |
| 2020-2054 | 35 | ₹287 |
| 2020-2059 | 40 | ₹326 |
| 2020-2069 | 50 | ₹389 |

As compared to Scenario1 and Scenario 2, the revenue capacities of this scenario able to finance 88 % of the capital investments required in urban infrastructure by 2020. It was evident that, if the revision of rental values takes place as per the provisions of regulating acts, the revenue strength of the plots would increase significantly.

### *5.4 Scenario 4, Revenue Optimization Through Change Of Land Use And Revision Of Rental Values*

In this scenario, conversion of land use based on potential rental value and maximization of revenue area in all possible categories was permitted in the linear programming model. It was observed that by allowing the change of land use from markets to shopping complex, both the revenue area and returns were increasing as compared to scenario 2 and 3. However, the existing public lands for vegetable and flower markets have been the major economic source for significant employment in an around GMC and were reserved for same use in this model. Whereas few other public lands in markets category have mix of commercial shops, which can be accommodated even in shopping complexes and by allowing the conversion of land use of these plots fetch more potential area and revenue for GMC. This scenario has permitted the change of land use of few plots in markets to other land uses and aimed at maximizing the revenue area for GMC. Besides, the change of land use with higher development costs was not a constraint in this scenario, while allowing the revision of rental values of all categories. The objectives of each category considered in the model are as follows:

1. Shopping Complex (Revision of rental values based on market value; Scenario 3)
2. Markets (Conversion of land use, revision of rental values based on market value)
3. Vacant Lands (Conversion of land use to markets and revision of rental value)
4. Land Lease (Conversion of land use to shopping complex and revision of rental value)
5. Municipal Buildings& Quarters (Conversion of land use to other land uses)
6. Others (Conversion of land use from others to markets and Revision of rental value based on market value)

Objective Function Overall – Revenue Optimization by utilizing the developable area

$$Z = x_B + x_C + x_D + x_L + x_{LB} + x_M + x_Q + x_O + x_P + x_R + x_S + x_{SB} + x_{SC} + x_U + x_{VC}$$

**a. Shopping Complex**

$$X_{SC} = \sum_{sc=1}^{20} r x_{sc}$$

**Objective function and constraints**

$$X_{SC} = 2526(SC_{r1}) + 4001(SC_{r2}) + 4096(SC_{r3}) + 1354(SC_{r4}) + 1589(SC_{r5}) + 4620(SC_{r6}) + 1588(SC_{r7}) + 3945(SC_{r8}) + 2088(SC_{r9}) + 1911(SC_{r10}) + 1788(SC_{r11}) + 3438(SC_{r12}) + 3330(SC_{r13}) + 2238(SC_{r14}) + 4389(SC_{r15}) + 2430(SC_{r16}) + 5620(SC_{r17}) + 1709(SC_{r18}) + 2891(SC_{r19}) + 3246(SC_{r20})$$

$$\sum_{sc=1}^{20} x_{sc} \leq 22455 \text{ (Maxmium Area under revenue category)} \ldots\ldots\ldots 1$$

$SC_n = SC_{rn}$; rn= maximum net revenue area of each plot, 10% of the total market value of the plot or the prevailing rental value of the plot, whichever is higher.

$$x_{sc1} + x_{sc2} + x_{sc3} + x_{sc4} + x_{sc5} + \ldots\ldots\ldots + x_{scn} \geq 0 \ (DevelopmentCost) \ldots 2$$

**b. Markets**

$$x_M = \sum_{rmn=1}^{6} x_{rmn}$$

$$x_M = \sum_{rm=1}^{n} x_{rm} + \sum_{rsm=1}^{n} x_{rsm} + \sum_{rqm=1}^{n} x_{rqm} + \sum_{rvm=1}^{n} x_{rvm} + \sum_{rom=1}^{n} x_{rom} + \sum_{rlm=1}^{n} x_{rlm}$$

$$\sum_{m=1}^{n} x_m \geq 1920 \ (minimumMarketAreareserved) \ldots\ldots\ldots 3$$

$$\sum_{rmn=1}^{6} x_{rmn} \leq 27104 \ (Maximum\ Area\ under\ revenue\ Category) \ldots\ldots\ldots 4$$

$$x_{rm} = 12066(m_{r1}) + 5330(m_{r2}) \ldots\ldots\ldots 5$$

$m_n = m_{rn}$; rn= maximum net revenue area of each plot, 10% of the total market value of the plot or the prevailing rental value of the plot, whichever is higher.

**c. Vacant Land**

$$x_{VL} = \sum_{vlm=1}^{n} r x_{vlm}$$

$$X_{VL} = 2292(vm_{r1}) + 2092(vm_{r2}) + 1792(vm_{r3}) + 1592(vm_{r4})$$

$$x_{VL} = 3291 \text{ (Maximum Area under Revenue Category)} \ldots\ldots\ldots 6$$

$vl_n = vl_{rn}$; rn= maximum net revenue area of each plot

**d. Municipal Office Buildings/Quarters**

$$X_Q = \sum_{rq=1}^{8} x_{rq}$$

$$x_{rq} = -12(q_{r1}) + 1200(q_{r2}) - 12(q_{r3}) + 1500(q_{r4} - 12(q_{r5}) + 44(q_{r6}) + 500(q_{r7}) + 33(q_{r8})$$

$$X_Q = 14679 \text{(Maximum Area under Revenue Category)} \ldots\ldots 7$$

$q_n = q_{rn}$; rn= maximum net revenue area of each plot

**e. Land Lease**

$$X_L = \sum_{rl=1}^{7} x_r$$

$$x_{rl} = 588(l_{r1}) + 588(l_{r2}) + 1578(l_{r3}) + 1188(l_{r4}) + 2088(l_{r5}) + 588(l_{r6}) + 588(l_{r7})$$

$$X_L = 16484.2 \text{(Maximum Area under Revenue Category)} \ldots\ldots 08$$

$$x_{rl} = r_1 \times l_1 + r_2 \times l_2 + \ldots\ldots\ldots + r_9 \times l_9$$

l = Net revenue area of the plot in sq.m;

**f. Others**

$$x_O = \sum_{rn=1}^{1} x_{rm}$$

Change of land use to markets

$$x_{ro} = 2288(X_o) \ldots\ldots 9$$

$$X_o = 4032 \text{ (Maximum Area under Revenue Category)} \ldots\ldots 10$$

***Other constraints and Assumptions,*** Equations from 14 to 30, of Scenario 1 refer to all the reservation of lands of restricted category, remains same in Scenario 4.

### *Results of Scenario 4*

| Time Period | Years | NPV 2019 (Crores) |
|---|---|---|
| 2020-2029 | 10 | ₹41 |
| 2020-2034 | 15 | ₹99 |
| 2020-2039 | 20 | ₹152 |
| 2020-2044 | 25 | ₹202 |
| 2020-2049 | 30 | ₹247 |
| 2020-2054 | 35 | ₹287 |
| 2020-2059 | 40 | ₹326 |
| 2020-2069 | 50 | ₹389 |

By allowing the change of land use form markets to other category based on the revenues and by allowing the revision of rental values in other categories, GMC shows to achieve the revenue potential of INR.447 crores from public land lease by 2020 and can finance 100% of the capital investments required in urban infrastructure. Thus, it can be assumed that without

any additional land acquisition or debts, the municipality can finance the urban infrastructure investments by reserving the lands of public leases for 50 years from the year 2020.

### *5.4 Hypothesis Test*

The Wilcoxon signed rank test, a non-parametric test was used to compare the results, financial strengths of public lands of business as usual scenario and other scenarios formulated. The critical value of Z for 8 variables is 10 at 5% of alfa, and it is observed that the results of others simulations are less than 10. Therefore, the null hypothesis is rejected.

## 6. Conclusion And Way Forward

The assessment on municipal finances of GMC clearly indicates that the municipal revenues realized were not sufficient and the share of own revenues was very low towards total expenditures. When the expenditures were compared to normative levels, the capacity of own revenues reported much below 20% with 70% underspending levels on urban infrastructure and services in GMC, and the need for revision of user charges, property taxes and exploring other potential revenue sources to improve the municipal finances was established. Unlike China, municipal governments in India don't have access to personnel income tax and business income taxes and required to raise municipal revenues through alternative sources where monetization of public lands become a trust area for assessing their revenue potentials, and leasing strategies for public lands have to be based on the market potentials. Thus, revenue optimization techniques using linear programming model finds its application for this case area. The results indicate that existing public lands of GMC has fiscal capacity of financing 40% of the investments required for urban infrastructure by 2020 while reserving land revenues for 50 years. The optimization scenarios proposed under different simulations as done in this research have potentials to realize 240% more revenues compared to 'business as usual' scenario and hence, provide new policy insights for leasing public lands in a revenue optimization perspective. Further, the scenarios developed had recognized and considered the reservation of lands for social purposes and didn't exploit them for monetary benefits. The study also indicates how local governments can estimate potentials of their own revenues and establish revenue targets.

Overall, it is concluded that the revenue potentials of public lands can't be determined based on the realized revenues alone and it is essential to consider the following aspects while estimating the potential of public lands: *a) existing rental and potential value by category, b) permissible developable area within the plot c) reservations on leases d) time period of lease e) revision of rental values f) development costs and net present value of future revenues from leases g)marketable public land for revenue maximization.* The outcomes of this study convey that reservation of public land lease revenues towards capital investments on urban infrastructure services is an important policy recommendation that municipalities have to undertake and approaches on building more marketable public land through planning instruments will further increase the fiscal capacity of municipality.

## References

Archer RW, Wu Chung-Tong (n.d.) Comments on land leasing and urban planning: Lessons from Hong Kong. *Regional Development Dialogue*. 15(2): 2-22.

Ballaney S; Bertaud M-A; Annez PC, Koshy CK, Nair, Bindu P, B, Phatak V, Thawakar V. (2013). Inventory of public land in Ahmedabad, Gujarat, India (English). *Policy Research working paper*; no. WPS 6664. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/724551468049195991/Inventory-of-public-land-in-Ahmedabad-Gujarat-India

Ding C. (2005). Land acquisition in China: Reform and assessment. *Lincoln Institute of Land Policy*, Working paper 05, CDI.

Farvacque C, McAuslan P, Farvacque C, PatriK. (1992). Reforming urban land policies and institutions in developing countries (English). *Urban management programme policy paper*; UMPP no. 5. Washington, DC: The World Bank. http://documents.worldbank.org/curated/en/257481468763516241/Reforming-urban-land-policies-and-institutions-in-developing-countries

Keshishian M. (2006). Making cities work: Assessment and implementation toolkit, *PADO,* USAID & *Andrew Young School of Policy Studies, Georgia State University*. Washington DC.

High Power Expert Committee (HPEC). (2011). Report on Indian urban infrastructure and services, *Ministry of Urban Development, Government of India*. New Delhi.

Lin CS, Ho PS. (2005). The state, land system and land development process in contemporary China. *Annals of the association of American Geographers*. 95(2): 411-436.

Lin CG, Zhang YA. (2014). Emerging spaces of neoliberal urbanism in China: Land commodification, municipal finance and local economic growth in prefecture-level cities. *Urban Studies (Special Issue)*. 1-25.

Mathur OP. (2011). Municipal finance matters. *National Institute of Public Finance and Policy*. New Delhi: Asian Development Bank.

Mathur OP. (2013). Municipal finance matters - Indian municipal finance report. Technical Assistance Consultant's Report, *Asian Development Bank*, National Institute of Public Finance and Policy, New Delhi.

Mckinsey G. (2010). India's urban awakening: building inclusive cities, sustaining economic growth.

Mohanty PK. (2014). Cities and public policy: an urban agenda for India. *Sage Publications India Pvt Ltd.*, New Delhi, India. 186-216

Mohanty PK. (2016). Financing cities in India: municipal reforms, fiscal accountability and urban infrastructure (Vol. 1st Edition). New Delhi, India: Sage Publication India Pvt Ltd.

Mohanty PK, Misra BM, Goyal R, Jeromi PD. (2007). Municipal finance in India; an assessment. Study No.26, *Department of Economic Analysis and Policy*, Reserve Bank of India, Mumbai.

Ministry of Urban Development (MOUD). (2017). Value capture finance policy framework. Government of India.

Pan F, Zhang F, Zhu S, Wojcik D. (2016). Developing by borrowing? inter-jurisdictional competition, land finance and local debt accumulation in China. *Urban Studies*, 20.

Patricia CA, Gangopadhyav S. (2017). India's public lands: responsive, transparent, and fiscally responsible asset management. *IDF*.

Peterson GE; Kaganova O. (2010). Integrating land financing into subnational fiscal management (English). *Policy Research working paper*; no. WPS 5409. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/173371468149668444/Integrating-land-financing-into-subnational-fiscal-management.

Peterson GE. (2006). Land leasing and land sale as an infrastructure-financing option (English). *Policy, Research working paper*; no. WPS 4043. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/133061468142165168/Land-leasing-and-land-sale-as-an-infrastructure-financing-option.

Peterson GE. (2009). Unlocking land values to finance urban infrastructure: land-based financing options for cities. *Infrastructure Development Finance Company*. New Delhi: Oxford University Press.

Phatak, VK. (2013.) Land based fiscal tools and practices for generating additional financial resources. *Ministry of Urban Development and World Bank*. New Delhi: Government of India.

Phatak VK. (2009). Charges on land development rights as a financing resource for urban development. *Infrastructure Development Finance Company*. New Delhi: 3i Network.

Roy B, Johannes L. (1992). Urban public finance in developing countries. New York: *Oxford University Press.*

Sridhar KS, Reddy AV. (2009). Land as a municipal financing Option: a pilot study from India. Public Affairs Center, Bangalore. *Study Report*.

Srinivasan G. (2010). Operations research: principles and applications (2nd Edition ed.). New Delhi, India: PHI Learning Private Limited.

Tao R, Su F, Liu M & Cao G. (2010). Land leasing and local public finance in China's regional development: Evidence from prefecture level cities. Urban Studies. 47(10): 2217-2236.

Taha H. (1999). Operations research (5th Edition ed.). Singapore: Prentice-Hall International.

Thirteenth Finance Commission. (2009). Volume 1: Report. Government of India. New Delhi. https://fincomindia.nic.in/ShowContentOne.aspx?id=28&Section=1.

Yeh G-O A. (1994). Land leasing and urban planning: lessons from Hongkong. *Regional Development Dialogue*. 15(2): 3-28.