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Research Article

NEED BASED ALLOCATION-LOCATION OF PUBLIC DISTRIBUTION SYSTEM USING GEOGRAPHICAL INFORMATION SYSTEM (GIS)

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ABSTRACT

Ahmed Tritah, (2003) investigated the effect of food subsidies on food security and poverty in India using propensity score matching methods the author found that while the Public Distribution System (PDS) has a poor record on reaching the poor, conditional on having access to PDS, the subsidy is entirely consumed. Moreover it had been found that food subsidies going through the PDS exert a multiplier effect on quantity consumed. These findings point to are evaluation of the impact of PDS with respect to its main objective, which is food security. Similar method had been used *to study the public distribution system in Kumbakonam, with data gathered from various sources.* The present research has been aimed to analyze the feasibility of existing locations and suggest the alternate locations using operational research methods. *All the ward wise coordinates were measured (x and y coordinates of the exact lat and long positions) along with the respective village population as weights were tabulated to compute ALTERN (a heuristic algorithm) to find the optimum location model for the* PDS *in the Town. Based on the existing and alternate locations of the maps it is useful to find the proposed locations based on the ALTERN algorithm and the model would provide optimum solutions. It is heuristic solution to the M-center location allocation problem. The algorithm alternates between locating centers and allocating demand points beginning with either, until assigned to the closest is at the minimum point of its set of demand points.*

INTRODUCTION

Public Distribution System (PDS) is considered as principal instrument in the hands of State Governments for providing safety net to the poor against the spiraling rise in prices of essential commodities. In this regard Tamil Nadu sets a model in implementing the PDS as universal system. Here the involvement of the Cooperative Societies is noteworthy, since they cover more than 93 per cent of the FPS in Tamil Nadu. Further, the involvement of women SHGs in the distribution network ensures safety, transparency, and accessibility and above all reduced the transaction cost. Public Distribution System (PDS) is a poverty alleviation programmed and contributes towards the social welfare of the people. Essential commodities like rice, wheat, sugar, kerosene and the like are supplied to the people under the PDS at reasonable prices. PDS is a boon to the people living below the poverty line. PDS is the primary social welfare and antipoverty programmed of the Government of India. Revamped Public Distribution System (RPDS) has been initiated by the Government of India from the year 1992 in order to serve and provide essential commodities to the people living in remote, backward and hilly areas. Government introduced Targeted Public Distribution System (TPDS) in the year 1997. Central Government and State Governments have been actively involved in steering the operations for the success of the PDS. It is not possible to neglect the PDS in India, because majority of the Indian population are living in rural areas and their standard of living is also poor and they cannot afford to pay the prevailing market prices for the essential commodities. Central Government has provided Rs. 6,066 Crore for food subsidy in the Union Budget for the year 1996-97. This has increased over the years and stood at Rs. 21,200 crores in 2002-03. Tamil Nadu sets a model in implementing the PDS as universal system for the cause of eradicating poverty and improving standard of living of the people living below the poverty line. Timely supply of essential commodities is the basic element for the success of the PDS. Infrastructure that is, Fair Price Shops (FPS), go down facilities and employees are other requisites of the PDS.

Food Security

Food Security means the availability of food at all the times, access to all the persons in terms of quantity and quality which should be nutritionally adequate, that should be acceptable within the given culture and food habit. It is indicated by physical and economic accessibility of food. The physical access to food depends on production, procurement, storage, buffer stock and supply of food where as the economic access

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to food demands purchasing power of the consumer. In India, PDS as policy covers all the above items necessary for food security .The policy of PDS has been made primarily with the objective of providing food security to the poor and simultaneously fixing remunerative prices to the producers. In fact the latter function was better served in course of the implementation of the PDS. The Green Revolution reduced India's grain imports substantially; it did not have similar impact on reduction of hunger or food insecurity. It has been argued that hunger is not caused by shortage of food and thus cannot be eliminated by producing more. Alleviation of hunger depends upon the economic, political and cultural rules that people make.

The Food Subsidy

The food subsidy arises from government procurement and distribution of two commodities: wheat and rice. Significantly, coarse cereals (bajra and jowar) do not receive subsidies even though, in some states, they are major components of food budgets of poor households. In the past subsidies have been offered on other commodities such as edible oils and most notably sugar. These are now unimportant. Between 1971/72 and 2001/02, the food subsidy has averaged a little less than 0.5 per cent of GDP. Broken up by decade, the food subsidy has increased over this period and is nearly 0.6 per cent of GDP in the decade leading up to 2001/02. In recent years, the food subsidy has risen sharply above the historical averages (to nearly 0.9 per cent of GDP) and it remains to be seen whether this rise is permanent or transitory. The division of the food subsidy into the distribution and buffer stock subsidy varies from year to year. However, it is not uncommon at all for the buffer stock subsidy to exceed the distribution subsidy. Indeed, this has been the typical pattern in the late 1990s. This happens whenever the government carries large stocks.

Stabilization Processes

In an economy, where the government stabilizes annual supplies, procurement and public distribution sales should balance over the span of a crop cycle (typically about 5-6 years). This was indeed the case over the two decades between 1972/73 and 1991/92. However, since 1992/93, procurement has been consistently larger than public distribution sales. Grain surpluses are regionally concentrated – in Punjab, Aryan, Uttar Pradesh and Andhra Pradesh. In the 1990s, it is argued, that these states were able to exercise greater influence over the procurement prices determined by the Central government because of the formation of coalition governments at the Centre. Indeed, stocks can be so large that private stocks might not be carried at all as it happened in the wheat market in 2001.

At this time, the wheat stocks with the government were equivalent to the annual market supplies. Grain stocks were brought down by a combination of special measures including subsidized exports, expanded welfare programs and open market sales as well as the fortuitous circumstance of a drought in 2002/03.

Reaching the Poor

In 1999, 36 per cent of poor households (i.e., households with expenditures less than poverty line) report purchases of rice or wheat from the public distribution system. The small disparity in overall participation rates is driven by the urban sector where 37 per cent of poor households access the PDS as against 23 per cent of all no poor households. These figures establish that while the PDS includes. More than 70 per cent of the poor use the PDS in Andhra Pradesh, Karnataka, Karalla and Thailand. Between 50 to 60 per cent of the poor use the PDS in Assam, Gujarat, and Orison. Participation rates of the poor vary between 6 to 22 per cent in Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh. As for the no poor, their participation rates are lower than that of the poor. However, the bias is of no practical consequence as the partial measures show the received subsidy to be small. In rural areas and for the bottom 4 expenditure deciles, subsidies account for about 1-2 per cent of total household expenditure.

Development of Public Distribution System in Tamilnadu

The Government of Tamilnadu is implementing PDS since the year 1964. The scheme Village Shop Programmed was introduced by the State with the intention to have one shop for one village in order to feed essential articles to rural public. Subsequently the scheme was converted into PDS with the intention of providing essential commodities to the public both in rural and urban areas at concession rate. Since the introduction of TPDS from 1.6.1997 the universal PDS is in operation in Tamilnadu with the Antyodaya Anna Yojana and the expanded Antyodaya Anna Yojana schemes. Under the universal PDS there is no discrimination of families on APL and BPL lines based on income.

Problem Statement

Kumbakonam is a temple town located in at the centre of Tamil Nadu. The town has been expanding like any other towns in India. The Population has also doubled within two decades due to inmigration. The town consisting of 51 wards at present and earlier it had only 36 wards. Fair price shops/ co-operative stores under the direct control of the state Government are distributing the essential commodities to the middle and poor class. These shops are catering the needs of the people distributed in the 51 wards. Field investigation in the study area reveals that, these fair price shops in the town are not evenly distributed. In other words these shops do not have access and people will have to travel and spend abnormal time to fetch the ration materials. The present study has been aimed to analyze the feasibility of existing locations and suggest the alternate locations using operational research methods.

Objectives

The following objectives have been formulated to fulfill the above problem in the town and they are:

1. To study the spatial distribution of fair price/ co-operative stores in the town using ArcGIS
2. To locate using GPS and analyze the locational efficiency of these shops, constraints and feasibility,
3. To suggest alternate locations based on the location allocation models so as to serve evenly, by traveling equal distance by the users in the town.

Methods of Analysis

To study the public Distribution System in Kumbakonam Town and a base map was collected from Municipal office. The

source map converted into digital data by scanning method and then geo referenced using the GPS and software tool ArcGIS 9.1 spatial features needed for thestudy of digitized geo reference to photographical maps using Arc map converted into shape file. Digitized spatial features layers such as outer boundary, ward boundary, river, Temple, Bus stand, Hospital, Hotel, Taxi Sand, Mahamaham tank are stored in shape files and the files are maintained in Arc catalog. Ration shops related details collected in the Taluk Supply Office, collected the details about the types of Ration cards, kerosene bunk details collected from the Taluk Supply Office of Kumbakonam. Using GPS instrument GS-20 used to collect the Geo-referenced points and Ration shops. Ration card wise map is prepared attribute designed for Rice, sugar, and kerosene. A Geographic information system has been created to acquire information regarding every Ration cards with the all attributes. To study the public distribution system in Kumbakonam, data have been gathered from the Taluks Supply office in Kumbakonam. All the ward wise coordinates were measured (x and y coordinates of the exact lat and long positions) along with the respective village population as weights were tabulated to compute ALTERN (a heuristic algorithm) to find the optimum location model for the Primary Health Centers in the district. Based on the existing and alternate locations of the maps it is useful to find the proposed locations based on the ALTERN algorithm and the model would provide optimum solutions. It is heuristic solution to the M-center location allocation problem. The algorithm alternates between locating centers and allocating demand points beginning with either, until assigned to the closest is at the minimum point of its set of demand points.

Study Area Description

Kumbakonam is one of the special grade municipal towns in Tamil Nadu. It is the second largest town in Thanjavur district with a population of over one hundred thousand. Kumbakonam is known as the “Temple City” and hence it is one of the most important cultural landscapes in south India. It is located in the Kaveri delta and acts as an important marketing centre in the district, which has wide scope for marketing for variousFarm products in its surrounding. Generally the town is located at the North – East of the Thanjavur district. The river Kaveri passes through the northern part of the town and is flowing from west to east. In the south of the river Arasalar passes and acts as the southern boundary of the town Kaveri is well connected with important towns and cities in Tamil Nadu through transport facilities. The town is exactly extending at 10° 57’ North latitude and 79° 28’ East longitudes.In 1886 a town committee was formed as administrative headquarters of Kumbakonam town and it had celebrated its centenary in the year 1966. The area extent of a town was only 7.68 sq.km. In the year 1866 and the municipality was upgraded into a selection grade municipality the boundaries of Kumbakonam town are as follows: River Kaveri is flowing in the Northern side and the river Arasalar is flowing in the Southern side, in the East the road running in front of court building and Narayana circle Present called Sekklum, and in the West from Arasalar River bridge to EllaiyammanKovil north east and unto Chettipadidhurai.

Distribution of Population

Kumbakonam has been divided into 45 wards for administrative purposes. Table-1 shows the ward-wise categories of male, female and total population for the year 2011.

Table 1 Distribution of Population in Kumbakonam: 2011

Ward No	Male	Female	Total
1	1620	1623	3244
2	1493	1470	2965
3	1592	1563	3158
4	1575	1618	3197
5	1540	1500	3040
6	1589	1438	3027
7	1526	1614	3147
8	1532	1430	2970
9	1565	1440	3014
10	1714	1642	3366
11	1633	1679	3323
12	1659	1636	3307
13	1541	1618	3172
14	1497	1480	2991
15	1467	1553	3020
16	1591	1654	3245
17	1590	1602	3192
18	1633	1547	3180
19	1564	1613	3177
20	1612	1621	3233
21	1680	1553	3233
22	1662	1695	3357
23	1701	1602	3303
24	1528	1452	2980
25	1536	1478	3014
26	1612	1531	3143
27	1613	1649	3262
28	1639	1638	3277
29	1609	1636	3245
30	1520	1471	2991
31	1589	1575	3164
32	1548	1517	3065
33	1655	1722	3377
34	1682	1613	3295
35	1618	1624	3242
36	1561	1618	3179
37	1502	1451	2953
38	1522	1479	3001
39	1537	1511	3048
40	1503	1502	3005
41	1535	1493	3028
42	1612	1564	3176
43	1572	1607	3179
44	1635	1676	3311
45	1566	1546	3112
Total	71,270	70544	141908

Source: District Statistical Hand Book

Density of Population

Population density various from the center to periphery and at present the density is 11,418 persons per sq. km. In wards 1, 2 and 44 the population density is very low category, which is less than 6000. In wards 1,2,6,7,24,25,26,31,36,43,45 the density is slight higher to more than 6000 the other wards are having a density of more than 10,000. But the density is more than 15,000 in wards 4,8,9,14,15,27,28,29 the highest density is more than 20,000 in the wards 20, 21, 22.

Heuristic Algorithm for Public Distribution Location decisions

These methods comprise sequences of computations, which it is believed will frequently lead to the desired solution. This belief is founded on the logic of the computations and is frequently supported by extensive empirical experience. Unlike the exact analytical methods, no proof exists that heuristic methods will find the best possible solution. The popularity of these methods results from their usefulness in situations where exact analytical methods for the problem studied either do not exist, or are prohibitively expensive, or when a range of possible "solutions" is desired from which policy makers may make a selection using criteria that had not been (and perhaps could not be) formalized in the algorithm used.

The location problem in most cases involves either the simultaneous or the sequential location of many facilities. In either case the best location for any one facility depends on the locations of the others in the system. For example, we have n demand points to be supplied at minimum cost by m centers. Where should the m centers be located? The solution could be to minimize average unit distance from the demand points to their closest supply point. In the multi facility case the demand the points are clustered in partitions around their respective supply centers. One important characteristic of this and all solutions to this problem is that the location of each source is optimum with respect to the points in its partition.

The algorithm is developed (see appendix for ALTERN Algorithm) from the above principle for a problem that the solution to the multi facility case involves partitions (groups) of the demand points with each facility located best with respect to its group. For any group, therefore, the problem reduces to finding the solution for the single facility case. In multi facility case the problem remaining is then, to find the partitions. The alternating algorithm starts with partitions surrounding arbitrary facility locations. After finding the optimum locations within each group, it then redefined the groups around the new locations and finds new center locations for these new groups. We will show that at every step the value of the objective function z decreases, until stability occurs.

The algorithm is repeated on the same set of data starting with different center locations, theresults may be better or worse than other runs of the algorithm. The number of iterations required before stability occurs is few. This has become, therefore, the most popular computerized algorithm to compute a large problem.

The algorithm uses the method of steepest descent in reaching a solution. The first estimate of the minimum point is the center of gravity and at each succeeding estimate a distance and direction are computed in order to locate the next estimate. The program will be terminated when the value of the location of the minimum point is within a specified tolerance, or when a specified maximum number of iterations have been performed, whichever is the first. The final result is the desired optimum point which minimizes distances. The point that derived is the optimum location for Referral hospitals, Public Health care service centers and the Health sub centers, with minimum aggregate distances from all demand points. That is, this optimum location is closest to all demand point in space.

Map Description

Kumbakonam town (study area map) was obtained from Talk Supply Office. The town map was scanned and then digitized using Arc GIS convert in the form of digital maps. The map was converted into digital format by tracing all the minute details, which is required for the Public Distribution System. Fig-1 Shows the Kumbakonam town, along with the general information related features of Temple, Hospitals, Hotels, Taxi stand, Mahamaham tank, Bus stand and river. These features have been traced using Arc GIS 9.0. This was geo referenced using GPS.

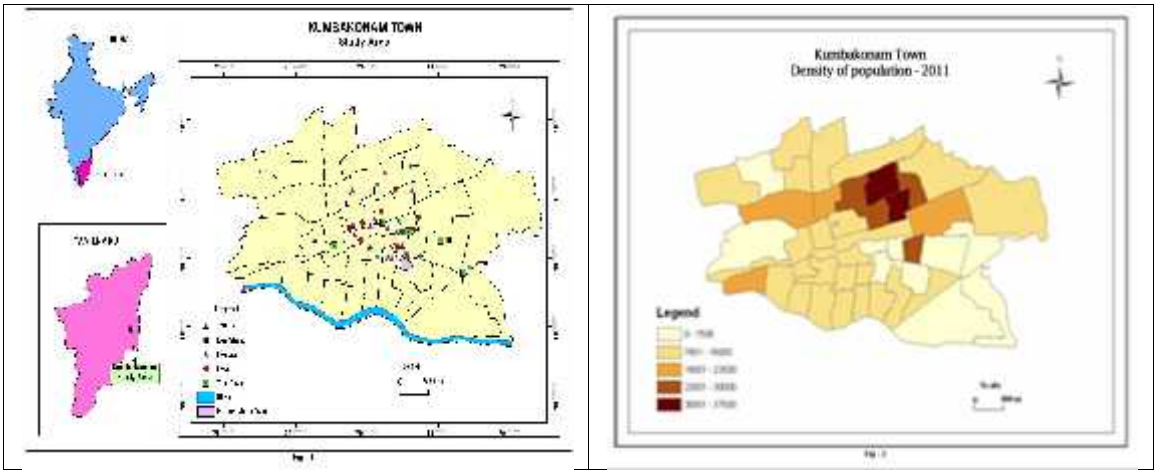

Figure-2 shows the density of population for–2011 census data. The density of population was calculated by obtaining the ratio of total population and total area of every ward. The density of population map was drawn using the Chloropleth map.

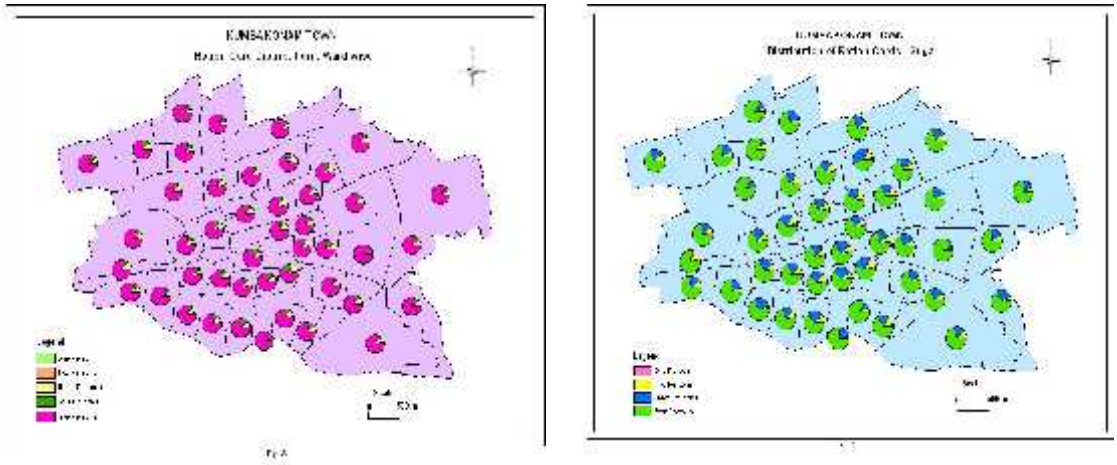

Figure-3 shows the pie chart map for the distribution of rice cards, particularly rice details. The details are classified according to the unit data in the attribute table. One person represents 12 kilos, two persons represent 14 kilos, three persons represent 16 kilos, four persons represent 18 kilos, and five persons represent 20 kilos of rice distribution. According to this classification pie chart for rice details were obtained for ward wise. The maximum level of rice distribution occurs in the three persons and five persons.

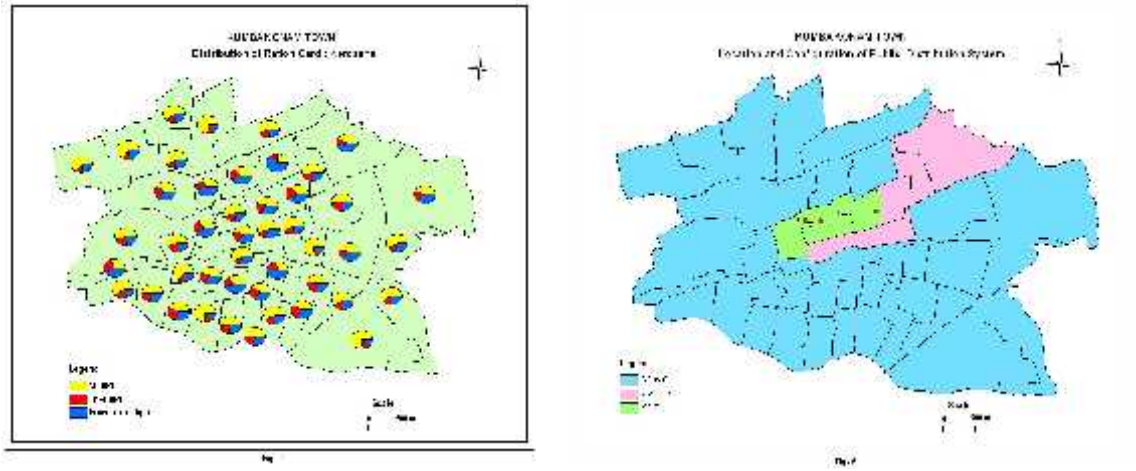

Figure-4 shows the pie chart map for the distribution of ration cards, particularly sugar details. The sugar details are classified according to the member data in the attribute table. Member 1 represents 1\2 kilo, member 2 represents 1 kilo, member 3 represents 1 1\2 kilos, and member 4 represents 2 kilos of sugar distribution. According to this classification pie chart for sugar details was also obtained for ward wise. The maximum level of sugar distribution occurs in member 4 (2 Kilos).

Figure-5 displays the pie chart map for the distribution of ration cards, particularly kerosene details. The kerosene details are classified according to the cylinder data in the attribute table. Cylinder 0 represents 6 liters, cylinder 1 represents 3 liters, and cylinder 2 represents not eligible kerosene.

According to this classification pie chart for kerosene details was obtained for ward wise. The maximum level of kerosene distribution occurs in cylinder 0 (6 liters).

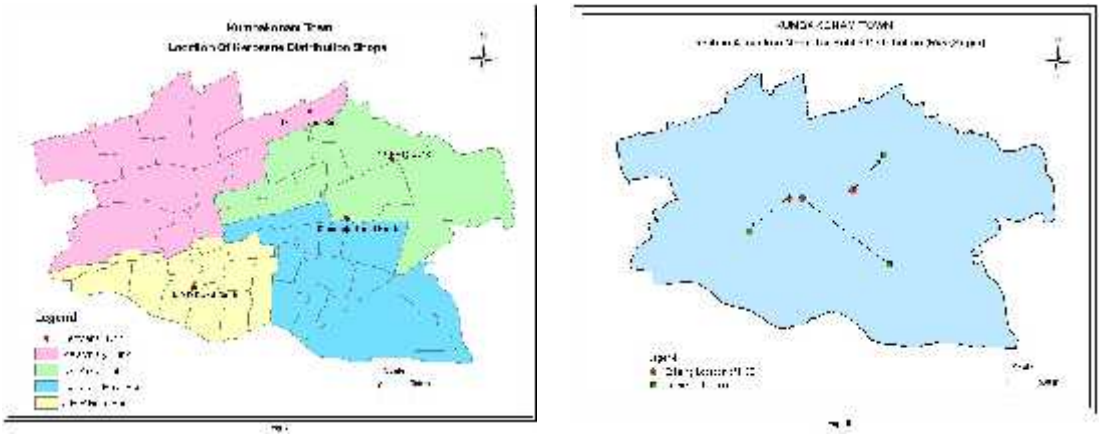

Figure-8 shows the location models for Public Distribution (Kerosene). This map shows the existing location and proposed location of the shops. The purpose of this allocation is for equal distribute of rice and sugar to the all wards of Kumbakonam town.

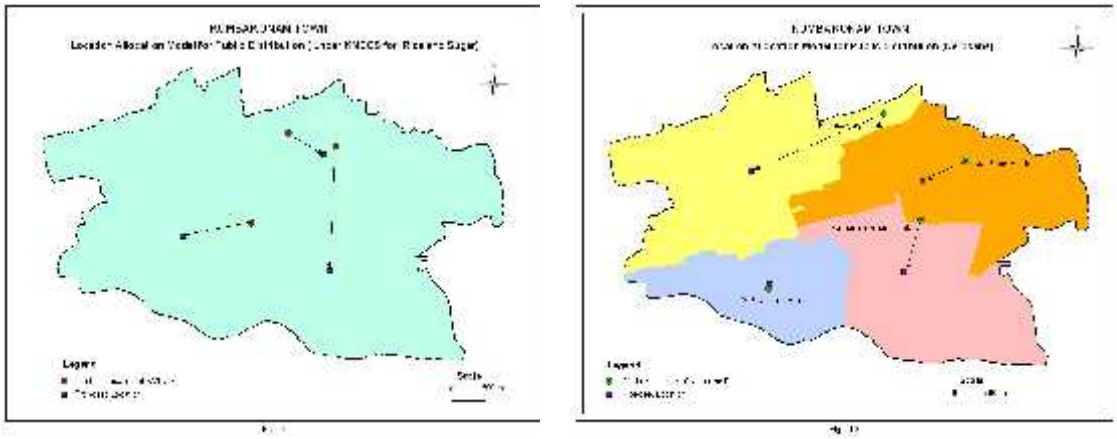

Figure-10 Shows the location allocation model for Public Distribution (Kerosene). The existing location of kerosene bunk and the proposed location were shown. By using this allocation the kerosene was equally distributed for the all ward of Kumbakonam town.

Figure-6 implies the location and configuration of public distribution system. This map represents the GPS point locations of the shops and the map was prepared using the SQL methods. The shops were classified into CCWS, KMECS, and KCS. In Kumbakonam town, CCWS shops was located in 39 wards, KMECS were located in 3 wards and KCS in 3 wards. The map was prepared by using the querying process.

Figure-7 indicates how the location Kerosene Distribution Shops 45 wards in Kumbakonam town. This map was prepared using SQL method. The kerosene bunk shops locate in four places namely Melacauveri bunk, Nall road bunk, Kamarajar road bunk, and ARR road bunk. Two bunks (Mela Cauvery and Nall road bunk) are located in the northern part of the Kumbakonam town.

Kamarajar road bunk was located in the western part of Kumbakonam town and ARR road bunk was located in southern part of the town. From the Mela Cauvery bunk, the kerosene was distributed to the wards (1,2,3,4,5,6,10,11,12,13,17,18) from the Nall road bunk distributed to the wards (7,8,9,19,20,21,23,24,25), from the Kamarajar bunk distributed to the wards (22,26,27,28,29,39,40,41,42,43,44,45), and ARR road bunk distributed to the wards (14,15,16,30,31,32,33,34,35,36,37,38).

Figure-9 displays the location allocation model for Public Distribution (under KMECS for rice and sugar). This map shows the existing location and proposed location of the shops. The purpose of this allocation is for equal distribute of rice and sugar to the all wards of Kumbakonam town.

CONCLUSION

In the present study the locational efficiency of PDS was studied using the ALTERN Heuristic algorithm for the best possible re-location so as to serve the entire town with equity and distribution principles. The existing systems have drawbacks like the uneven distribution and people will have to go for longer distances with time consuming to fetch the ration. The proposed model would simply this system if the administrators adopt this model for this town.

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