

Geospatial evaluation of TPDS in Palghar District, Maharashtra

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Dissertation Approval

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Declaration

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Abstract

Evaluation of Targeted Public Distribution System is complex process due to its large size and inter sectoral connections. The TPDS system is connected to the procurement of food grains, storage, transportation, distribution, food security, nutrition, and more. The study attempt to analyse the TPDS through the FPSs point of view. FPSs are the last point and interact directly with the beneficiaries. For analysing the performance of TPDS through FPSs, four major pillars are considered such as food distribution, infrastructure, technology, and monitoring. Under each pillar, there are several indicators selected to measure the performance. The variation of the indicators is discussed with the help of geospatial visualisation. Finally constructed a composite index named TPDS index which represent the performance of TPDS. Composite index are suitable to represent social phenomena which connects multiple factors.

Keywords: *Evaluation of TPDS, Ranking, Geospatial analysis of TPDS, Performance of TPDS at Palghar district, TPDS Index, Ranking framework.*

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Nomenclature

TPDS	Targeted Public Distribution System
GoI	Government of India
PDS	Public Distribution System
FCI	Food Cooperation of India
FPS	Fair Price Shops
NFSA	National Food Security Act
SDG	Sustainable Development Goals
GST	Geospatial Technology
ICDS	Integrated Child Development Scheme
PDR	Public Distribution Ratio

Chapter 1

Introduction

This chapter briefly discusses the introduction to the working and evaluation of the Targeted Public Distribution System (TPDS) in the Palghar district of Maharashtra with the help of geospatial technologies. Also, it mentions the background of TPDS in Maharashtra, the central research question, the scope of the study, and the organisation of chapters in the report.

1.1 Introduction about the Topic

TPDS is the most extensive food distribution program funded by any government to ensure food security. Approximately 81.34 Crores of people get benefited from TPDS organised by the Government of India (GoI). It was introduced in 1945 and the establishment of the Food Corporation of India (FCI) in 1960 and Fair Price Shops (FPS) under the Ministry of Consumer Affairs, Food and Public Distribution, GoI, improved the strength of PDS.

Apart from the economic growth, Maharashtra is still facing issues related to food security and poverty. According to NITI Ayog Sustainable Development Goal (SDG), Maharashtra has ranked 25th in No poverty (SDG 1) and has ranked 21st in no hunger (SDG 2) in 2018. In 2020-21, Maharashtra improved the ranking to 16 and 20 in SDG 1 and SDG 2, respectively. As per the Maharashtra government PDS portal, 52,549 FPSs are available across the state and deliver food grains to nearly 45 Lakh families.

The studies related to social phenomena lack the usage of geospatial technologies such as Geo Informatic System, Remote sensing, Global Positioning System, etc.

1.1.1 Need for Research

TPDS is the largest food distribution network globally, backed by a government. The primary objective of TPDS to ensure food security of the poor and poorest of the poor population of the country. Still, India is dropped behind in of Global Hunger Index. It is

required to study and evaluate the TPDS to find out the shoe pinchers of the system, how far TPDS succeed in delivering food grains to its beneficiaries, how the beneficiaries are access to TPDS, availability of TPDS and how they utilise the TPDS and how the knowledge in geospatial technologies can be efficiently used to study and analyse the situations. The study by developing an index can be used as a framework to evaluate the TPDS at different levels and different places.

1.2 Background

During Second World War, the scarcity of food increased due to the armed forces' high demands for food grains, the failure of Burma from where Rice was imported, and reduced food grain production in India. To mitigate the food grain shortage and to control the hike in the price of food grains, the Government started a rationing system in Mumbai in 1939. Later it expanded to other parts of the country (Mooij, 2008)

After that, India started controlling the food price by implementing food policies and imposing control over food grains; in 1942, GoI developed a new food department to coordinate all food policies (Mooij, 2008).

In 1957 the idea of Fair price shops(FPS) was proposed in a no-profit no-loss model. Still, FPS plays a crucial role in food distribution in India. Later, in 1965, the Food Corporation of India was established as a nodal office for procuring, storing and distributing food grains all over the country. In 1992 GoI introduced a Revamped Public Distribution System (RPDS), including different challenging areas such as deserts, mountains, remote villages etc. In 1997 PDS was renamed as Targeted PDS and focused on poor people of the country, and started giving subsidised food gains to 11 Cr families. TPDS works with the coordination of state and central governments. It divided the population into APL and BPL and focused on BPL households. The classification is done by the BPL census conducted by the Ministry of Rural Development (MoRD). In 2018, the Parliament of India passed the National Food Security Act, which improved TPDS by shifting the welfare model to a right-based approach. NFSA is ensuring the food security of the country by providing more subsidised foodgrains for poor people. An additional food security scheme was developed to aim at the poorest of poor people of the country, named Antyodaya Anna Yojana (AAY) on 25th December 2000(GoI, 2013a).

Targeted PDS in India is one of the most complicated and significant food distribution mechanisms globally. The TPDS is controlled by the Ministry of Consumer Affairs, food and public distribution. FCI performs the procurement of food grains. FCI purchase food grains from farmers or Mandi with a Minimum Support Price (MSP) and store the food grains on large godowns by Central Warehouse Cooperation (CWC) or State Warehouse Cooperation (SWC). FCI is also responsible for transportation food grains from the surplus production state to the low production state with the help of the Indian Railway. Different distributors at the district level collect the food grains from godowns to the FPSs. From the GoI dashboard, currently, there are 5,45,557 FPS functioning across the country and serving nearly 110 million households and providing foodgrains at a subsidised rate. FPSs plays a vital role and directly interact with the beneficiaries. So FPS is considered as the face of TPDS.

Since it is one of the complicated and most extensive systems, many problems exist. The issues fall into two major categories such as conceptual errors and functional errors. Different state governments use other parameters and methodologies to define APL and BPL. This makes a non-uniformity inside the country count the beneficiaries and their properties. Also, due to this, inclusion and exclusion error occurred – the household who required the benefits get excluded, and people with high income are included in BPL categories. This leads to conceptual errors in TPDS. Wrong implementation and corruption at various levels increase food grains' leakage at the operation level. These types of problems are together named functional errors.

To reduce the operational issues, GoI put forward many new initiatives such as Aadhar seeding, online allocation of food grains, computerisation of supply chains, Electronic Point of Sale (EPOS), etc. The GoI made introduced Aadhar authentication for enrolling on the NFSA programme by a notification dated 8th Feb 2017 to provide convenient and efficient transfer of food grains to the beneficiaries. As per the report published by the GoI, all 34 out of 36 states/UT are started online allocation of food grains and 31 out of 36 states/UT implemented an online supply chain management system. Automation of FPS completed by 91%. Few states like Assam, Meghalaya, Arunachal Pradesh and Uttarakhand need to improve in the automation of FPS(GoI, 2013b).

1.2.1 TPDS in Maharashtra

TPDS in Maharashtra controlled by the Department of food and civil supplies. The department deals with the demand and supply of essential commodity, price control and proper functioning of TPDS(*About The Department*, n.d.).

In Maharashtra, 1.55 Cr ration cards and 6.97 Cr beneficiaries are under NFSA. In the state 99% of the Aadhar seeding of ration cards is completed. Maharashtra successfully implemented 100% automation of FPS. Apart from that, Maharashtra won to implement online allocation, online supply chain management system, online grievance and toll-free number and online portal for transparency(GoI, 2013b)

Different states have different criteria for finding the category of beneficiaries. From the Maharashtra State Public distribution website, Maharashtra divided the beneficiaries into AAY, BPL, PHH, and APL. Their classification criteria and benefits are given in Table 1.1. AAY cards are distributed to people who are fall under BPL category and having social, residential or occupational vulnerability such as homeless households, household headed by widow, minor, disabled person or a person aged more than 60 years. The AAY card holders entitled with 35 Kg of grains per month at rate of 2Rs/ Kg for Wheat and 3 Rs/Kg. Whereas BPL card holders get a saffron coloured ration card and can entitle 5Kg/person at a subsidised price. The household, whose income is more than Rs. 1 Lakhs considered as APL and provide a white card. The APL card holders can purchase food grains without a subsidised price.

Table 1.1 Beneficiaries classification in Maharashtra

Source: Based on <http://www.mahafood.gov.in>

Type	Colour of cards	Criteria	Benefits	Price rate
AAY	Yellow Ration cards	Annual income up to Rs. 15,000/	35Kg/card/month	2 Rs for Wheat, 3 Rs for rice
BPL	Saffron Ration Cards	Annual income above Rs.15,000 and below Rs.1 lakh	5 Kg/Person	2 Rs for Wheat, 3 Rs for rice
PHH	Priority Household Stamp over saffron	Annual income <Rs.59,000/- (<44,000)	5 Kg/Person	2 Rs for Wheat, 3 Rs for rice

APL	White ration cards	Annual income more than 1L	15 Kg	No price subsidy
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According to the state PDS portal, Maharashtra has 52,549 FPS across the state serving 7,27,505 AAY families, 36,07,760 PHH families and 1,96,660 APL families.

The Table 1.2 describe the working style of FPS in urban areas of Maharashtra – Mumbai. Apart from Sunday, FPS is working everyday for 8 hours, and the timing is apt for the people who has some jobs. The FPS owner appointed labours to functioning the FPS, and they are unaware of the financial and stock details, regular updates of TPDS etc. In urban areas, selling of Non PDS items allowed, and many people are getting benefit from that. FPS are technologically updated in urban regions, where EPOS, electronic weighing machine, online pay services are available.

Table 1.2 Working of TPDS in Urban area of Maharashtra (Mumbai)

Source: Field visit

Timing	8:00 AM to 1:00 PM, 5:00 PM to 8:00PM, Sunday is holiday
Structure	FPS owner: Handle the government orders, get the money etc. Labors: Opening and distributing food grains
Services	Selling PDS items Selling non PDS items Online payment facilities Serving more than 1000 families
Machines available	EPOS machine Electronic weighing machine connected with EPOS machine
Others	Most of the people in Two shops fall under PHH category The stock will not carry forward for the next month. Allocation done automatically

	Wheat is more supplied than Rice
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1.2.2 Public Distribution Ratio

Public Distribution Ratio (PDR) is defined as the arithmetic ratio of total beneficiaries (AAY+BPL+APL) to the total number of FPS of a given area. PDR is inversely associated with the efficiency of the PDS. If PDR is high, the efficiency and penetration of TPDS are less, and if PDR is low, the efficiency and penetration of TPDS are high. As per the author suggested in his research, the ideal value of PDR is 400 (Kokane et al., 2021).

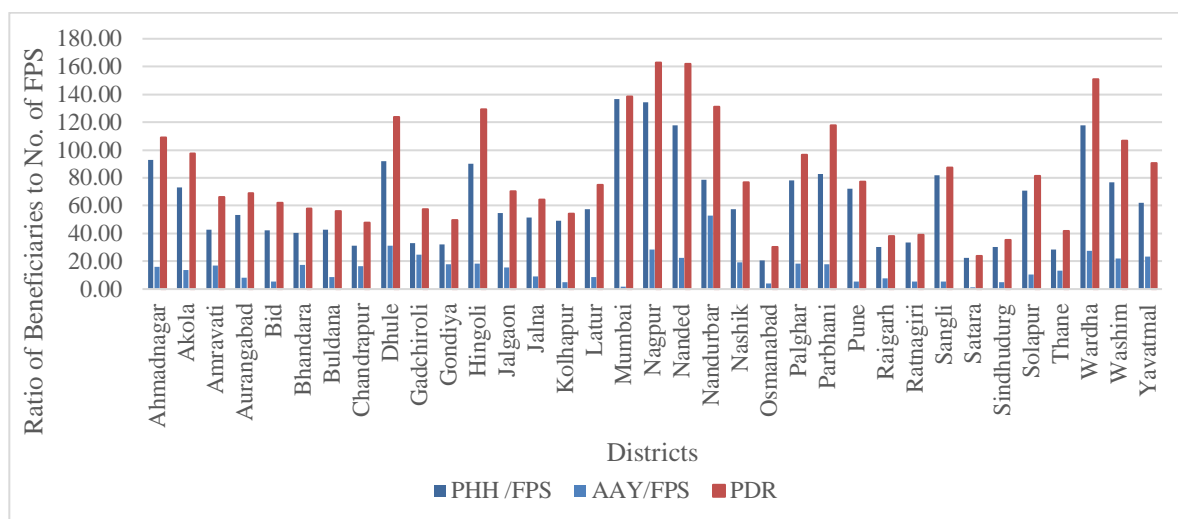


Figure 1.1 Distribution of FPSs in different districts of Maharashtra

Source: <https://mahaepos.gov.in/>

While PDR is Ratio of total beneficiaries to total FPS in a given region, Ratio of PHH beneficiaries to total FPS is also a good measure as majority of beneficiaries are in PHH category(55%). As per the Maharashtra PDS portal, the AAY and APL card holders in Palghar district is 16% and 29% respectively.

Figure 1.1 shows the distribution of FPSs and their corresponding card holders' distribution information of different districts of Maharashtra. The Ratio of PHH to FPS is high in all districts, which make high workload for the FPSs. The Ratio of AAY to FPS and

APL to FPS is comparatively lower than that of PHH because of a smaller number of AAY beneficiaries than PHH. The FPSs of Mumbai, Nagpur, Nanded, Wardha have the highest loads compared to other districts. On average, 136.80 PHH cardholders are served by an FPS in Mumbai. Similarly, 134.4 for Nagpur, 117.7 for Nanded and 117.5 for Wardha. Palghar district. When looking at PDR, similar trend is observed, as shown below.

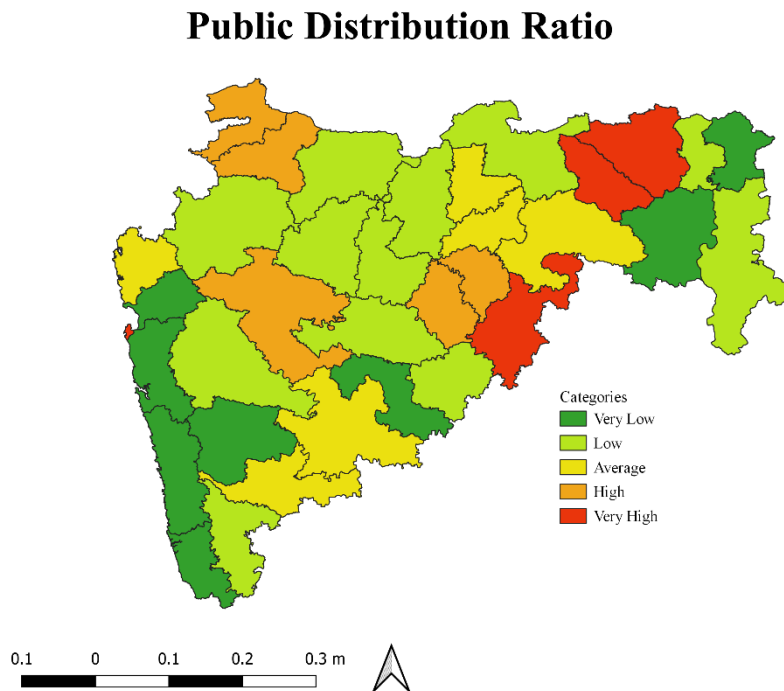


Figure 1.2 Visualisation of PHH/FPS

In Figure 1.2, based on PDR, all districts are classified into five equal classes as Very high (below 52), high (53-79), Average (80-107), Low (108-135) and Very low (above 135) and visualised. Nagpur, Nanded, Wardha districts are classified into the least performing category. Ahmednagar and Dhule are organised into a below-average category. The rest of the districts fall under the Average or above categories. Even the worst performing district is still better than the acceptable norm of PDR value 400. As per the notification of Maharashtra government on 9th June 2000, 400-500 is the ideal value for PDR in rural areas and 1600-1500 is ideal PDR for urban areas.

1.2.3 Number of FPSs per Population

Number of FPSs per population is a ratio of Number of FPSs to the population calculated by the dividing the population of a region by number of FPSs available in the region. Studies are proposed an FPS per 1350 population in urban areas, and an FPS per 1900 population in rural areas (Kokane et al., 2021).

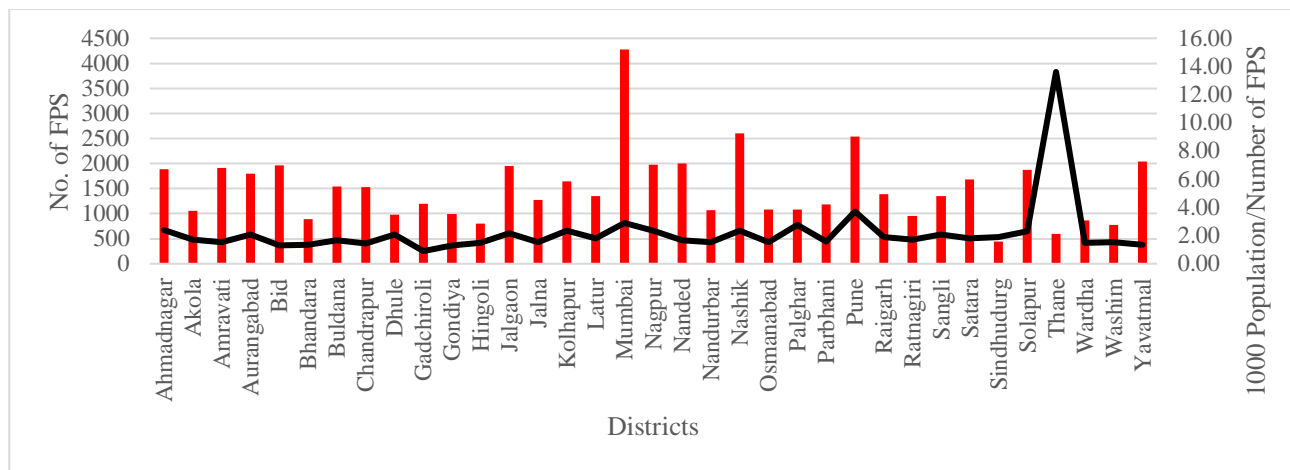


Figure 1.3 1000 Population/Number of FPS

Source: <https://mahaepos.gov.in/>

Figure 1.3 shows the relationship between the population of each district with the number of FPS available at each district. The population values are taken from census 2011, which is a limitation of the calculation. On average, 1700 people depend on a single FPS.

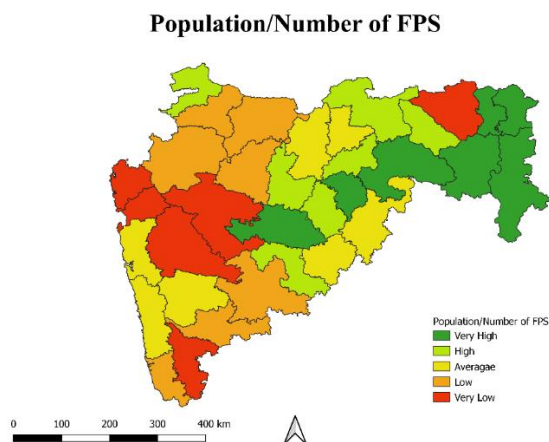


Figure 1.4 1000 Population/Number of FPS

From Figure 1.4, the districts are classified into five equal quantiles such as Very good (upto 1.4), Good (1.5 to 1.6), Average (1.7 to 1.9), below average (2 to 2.3) and Bad (above 2.3). It is clear that the urban districts are performed poor while it is not indicating that the TPDS system is failed to serve the beneficiaries.

1.2.4 Mapping of FPSs

As a part of the Strengthening and modernisation of TPDS under End End computerisation of TPDS operation, GoI decided to map all the FPS using GIS(Annual Report 2020-21, 2021). In Maharashtra, 49,083 FPSs are mapped and activities of mapping of 3466 FPSs under progress. Overall, 93.4% of FPSs are mapped in Maharashtra.

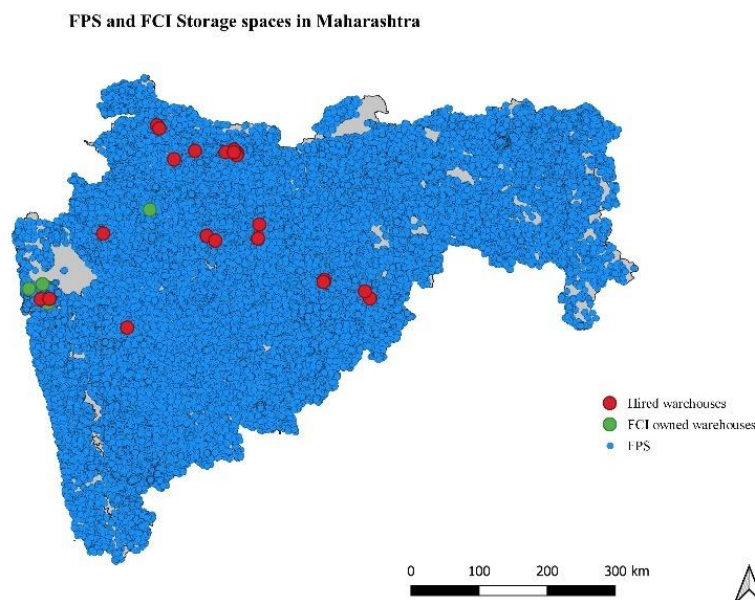


Figure 1.5 Distribution of FPS and FCI storage spaces in Maharashtra

Source: <https://nfsa.gov.in/public/nfsadashboard/PublicFPSDashboard.aspx>

Figure 1.5 demonstrate the distribution of FPSs in Maharashtra, with the storage facilities provided by FCI, CWC and Maharashtra State Warehouse Corporation (MSWC). The absence of bigger storage facilities at the Southern and Western part of the state is observable.

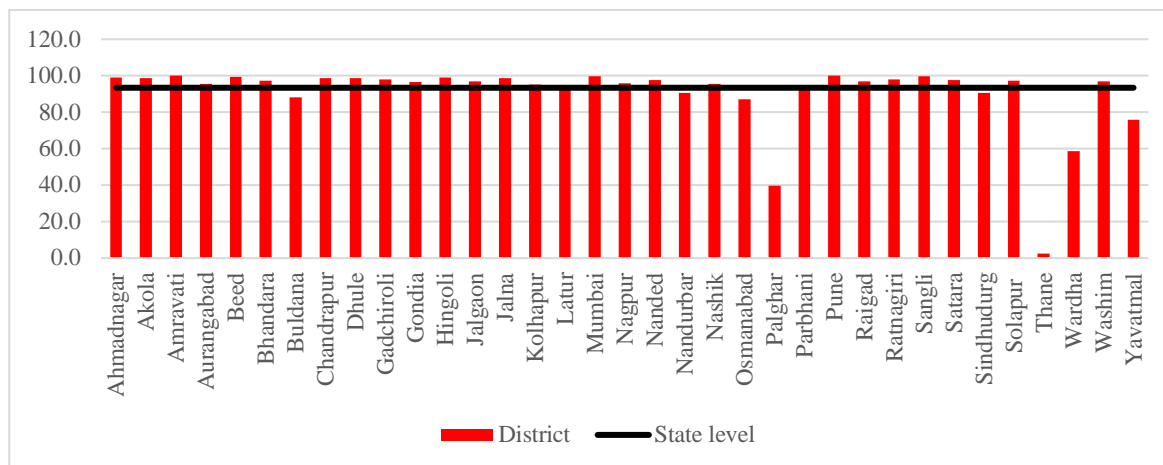


Figure 1.6 % of GIS mapped FPSs for each district

Figure 1.6 showed the % of FPSs mapped by GIS. Maharashtra as a whole, completed 93% of the mapping. Amravati and Pune completed 100% of mapping while Thane, Palghar, Wardha, Yavatmal, Buldana and Osmanabad are performed less than state average.

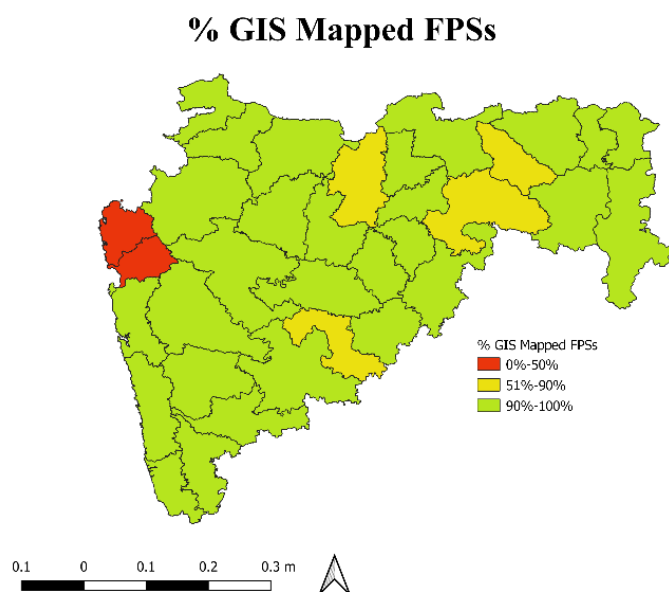


Figure 1.7 % of GIS mapped FPSs

Figure 1.7 visually explain the less performed districts towards the mapping of FPSs. Thane and Palghar are least performed and shown in red colour. Wardha, Yavatmal, Buldana and Osmanabad covered up to 90% and shown in yellow colour. Rest of the districts covered 90-100% of mapping.

1.3 Central Research Question

Whether the Targeted Public Distribution System (TPDS) in Maharashtra performing well? What are the parameters helpful in studying the performance of TPDS, and how it can be done?

1.4 Structure of Report

Chapter 1 Introduction – contains background, motivation to do the research, background of the problem and structure of the report.

Chapter 2 Literature review – review of the literature including background, basic info about the Palghar district, demography of the district, the study area and geospatial visualisation of the study area.

Chapter 3 – Research Methodology – contains a short note on the research methodology. Followed by research questions, objectives, sub research questions, tasks, subtasks, methods for each SRQ.

Chapter 4 – Evaluation of Palghar districts – contains the analysis of Palghar districts based on different parameters. Geospatial evaluation and visualisation models were used to analyse the trends visually across the district in Taluka wise.

Chapter 5 – Composite index for evaluating TPDS – contains the methodology to create the composite index and calculations for finding the TPDS index in detail.

Chapter 6 – Conclusion – contains the conclusions, includes a summary, answers to the research questions, the contribution of the current study, limitations of the current study, has a section on future work.

Chapter 2

Literature Review

Targeted Public Distribution System (TPDS) is the most extensive food distribution system globally. Many studies and academic research are going on the different dimensions of TPDS and how it helps make food security in India. The previous research in MTP1 discussed food security, the evolution of TPDS, and the role of TPDS in the country's food security.

This chapter discussed more different researchers and their views on the evaluation of TPDS. Google Scholar and Scopus are used to find out quality research papers. Evaluation of TPDS, performance evaluation of TPDS, Geospatial evaluation of TPDS, evaluation of TPDS in Maharashtra etc., are the keyword used to search documents. Nine scholarly articles are used to finalise the methodology of this research, and the rest of the articles are used to understand the context more.

A paper titled "Aadhar Enabled Public Distribution System (Aepds), Beneficiary Survey and Assessment Framework." (Gupte & Doctor, 2021) is evaluated PDS with the help of literature review and field visits to understand the existing technologies used. Based on the values, it developed a framework and scoring mechanism to analyse the working of TPDS. The research used different parameters under food grain distribution, infrastructure, digitisation and monitoring. Quality, quantity, accessibility and regularity come under food grain distribution, EPOS machine, FPS, Board with the necessary information, Biometric etc. are categorised under infrastructure, Data availability in websites, GIS mapping etc. comes under digitisation. Inspections, regular updates of food grain received, complaint registration options, complaints addressed, etc., fall under the monitoring category. A weighted value is given to each parameter based on the field survey and analysed.

Different states implemented different technologies to improve the functionality of TPDS. Chhattisgarh introduced end to end computerisation, Bihar introduced a coupon system, and Tamilnad introduced mobile FPS during 2014 (Gupte & Doctor, 2021).

A case study of Krishna District in Andhra Pradesh has pointed out the following outputs: AePDS helped to reduce the trips of beneficiaries, proper accounting of grains, accuracy in data updated and output (Gupte & Doctor, 2021).

A study by Sargar et al. analysed the qualitative aspects of TPDS like awareness, perception of households, problems of quality and quantity, the problem with FPS dealers and other supply-related issues by interviewing 6887 cardholders of 20 FPSs, of 20 different villages of Solapur district, Maharashtra, and found out food grains available adequately but required some changes in distribution pattern. Improper storage and mismanagement of distribution of food grains made some anomalies in TPDS (Sargar et al., 2014).

Another study by collecting and analysing secondary data and calculated a Food security index based on 14 indicators such as per capita food grain availability, yield of the land, area under cultivation, road length per 100 square KM, per capita income, % of PHH household, literacy, % primary workers to the total population, number of PDS per lakh population, access of drinking water etc. These indicators were classified into broad sections. Each indicator is normalised, an index for each team is calculated, and the geometric mean of indices is applied. It studies the different Taluka of Palghar districts based on the Index and spatially visualises for better understanding (Sarkar, 2019).

A recent study by Kokane et al. on the topic "Penetration and coverage of Public Distribution System (PDS), Mid-Day Meals (MDM) and Integrated Child Development Scheme (ICDS) in Palghar district of Maharashtra" calculated the arithmetic ratio of ration cardholders to the FPS of an area and called it as Public Distribution Ratio that coverage the level of penetration of TPDS. The distribution was shown in the map to give the spatial distribution of penetration of TPDS. The storage capacity ratio was also calculated, which provided an understanding of access to food grains in extreme conditions (Kokane et al., 2021).

"Evaluation Of Public Distribution System in India" by Kavita tried comparison of the offtake of PDS food grains of five states such as Uttar Pradesh, Tamil Nadu, Andhra Pradesh, West Bengal and Maharashtra. The study found out the level of different problems like lack of infrastructure and leakage. The study was done by Collecting data about quantity allocated and quantity of offtake, then calculated per capita quantity allocated and quantity of offtake per capita to compare different states (Kavita, 2014).

The study by NITI Aayog on the topic "Evaluation Study on Role of Public Distribution System in Shaping Household and Nutritional Security India" calculated the inclusion and exclusion error based on NSSO and IHDS II data sets. The study was done by comparing different economic indicators such as log Income per capita, negative income, castes etc. and applied statistical methods to reach the state-level data (NITI Aayog, 2016). The studies claimed that the TPDS played a crucial role in food consumption at household levels. There is a growth in the TPDS system in terms of different categories of cardholders. The results also claimed that there was better targeting between 2004-05 to 2011-12, with a reduction in exclusion errors (NITI Aayog, 2016).

Department of Food and Public Distribution evaluated the TPDS of Assam, Bihar, Chhattisgarh, Karnataka, Uttar Pradesh, and West Bengal. The study was done by collecting a large amount of primary data with careful selection of samples from rural and urban regions of mentioned states and analysed the data to find out the average price paid for purchases, distance from FPSs and beneficiaries, time taken to complete a transaction, quality of food grains etc. (Department of Food and Public Distribution, 2015).

Another study performed by the study was based on two hypotheses: TPDS worked perfectly, and people preferred grains over cash transfer. The study focused on the Beed district of Palghar district and was done by a primary survey of research areas. Data were collected about monthly income and calculated the amount used for purchasing food grains from FPS.

A case study on the working and performance of TPDS in Maharashtra done by Chandanshiv & S.S Narwade found that decentralisation of procurement and storage reduced the transportation and storage cost of TPDS. Also, the computerisation of TPDS improved the performance of the TPDS. The dependency of landless labours on TPDS is significant. The quantity of the food grain is not sufficient and distributed less than the allotted amount of food grains (Chandanshiv & S.S Narwade, 2013). The study was conducted based on two hypotheses: TPDS worked perfectly, and people preferred grains over cash transfer. The study focused on the Beed district of Palghar district and was done by a primary survey of research areas. Data were collected about monthly income and calculated the amount used for purchasing food grains from FPS (Chandanshiv & S.S Narwade, 2013).

Planning Commission India did early studies with the help of Programme Evaluation Organisation by national level surveying about errors in TPDS, leakage of food grains and

effective costs benefits of the TPDS to different categories such as AAY, BPL and APL provided key findings to change the TPDS system. The studies concluded that TPDS neither helped the poor nor reduced the country's financial burden on food security (PLANNING COMMISSION INDIA, 2005).

More literature and scholarly articles are available on the evaluation of performance and working of TPDS on different levels such as district, state, and nation as a whole. This research is trying to find a straightforward method to analyse and evaluate using GIS methodologies.

Chapter 3

Research Methodology

Research must set Research objectives (ROs), Research Questions (RQ) and a suitable methodology to make reliable and unbiased answers to the research questions. This chapter deals with the need for the research, Research Objectives, Research Questions and Methodology, timeline and methods used to analyse the interpret the data to find out the answers for the Research Questions.

The Research Objectives are,

1. Evaluate the performance of TPDS of Palghar district, analysis using secondary data and GIS technologies
2. To construct a composite index for evaluating TPDS in the Palghar district and verify ground reality.

From the above Research Objectives, the following Research questions and sub research questions are generated.

1. Evaluate the performance of TPDS of Palghar district, analysis using secondary data and GIS technologies
 - a. What are the different parameters will help to analyse the performance of TPDS?
 - b. What are the different resources of data to perform analysis?
 - c. What are the different trends in performance of TPDS in Palghar district?
2. To construct a composite index for evaluating TPDS in Palghar district and verify with ground reality
 - a. What are ranks for different Taluka based on the constructed Index?
 - b. What is the spatial distribution of the Index in Palghar district?
 - c. Whether the composite Index provides real picture of Palghar?

3.1 Research Design

This section provides information about the division of research questions into sub research questions and tasks associated with each SRS. The research design is shown in Table 3.1. It contains two research objectives and two research questions derived from the objectives. Each research question is divided into sub research questions. Each sub-questions is further divided into different tasks for easy execution of the research.

Table 3.1 Research Design

Sr No	Objectives	Research Questions	Sub Research Questions	Methodologies
1	Evaluate the performance of TPDS of Palghar district, analysis using secondary data and GIS technologies	What are the different parameters that will help analyse the performance of TPDS?	What are the different parameters?	Literature Review
		What are the different resources of data to perform the analysis?	What are the different sources of data?	Literature Review
			How to handle missing data?	Secondary data analysis
		What are the different trends in the performance of TPDS in the Palghar district?	What are the different trends	Secondary data analysis
			How the parameter varies across different Talukas of Palghar districts	Secondary data analysis GIS analysis
2	To construct a composite index for evaluating TPDS in Palghar district and verify with ground reality	What are the ranks for different Taluka based on the constructed Index?	How to construct a composite index	Literature Review
			What are the parameters that need to consider for the Index	Literature Review

		What is the spatial distribution of the Index in the Palghar district?	How it spatially distributed in Palghar	GIS analysis
		Whether the composite Index provides an accurate picture of Palghar?	Whether the findings of research match with the reality	Field visit

3.1.1 Selection of Parameters

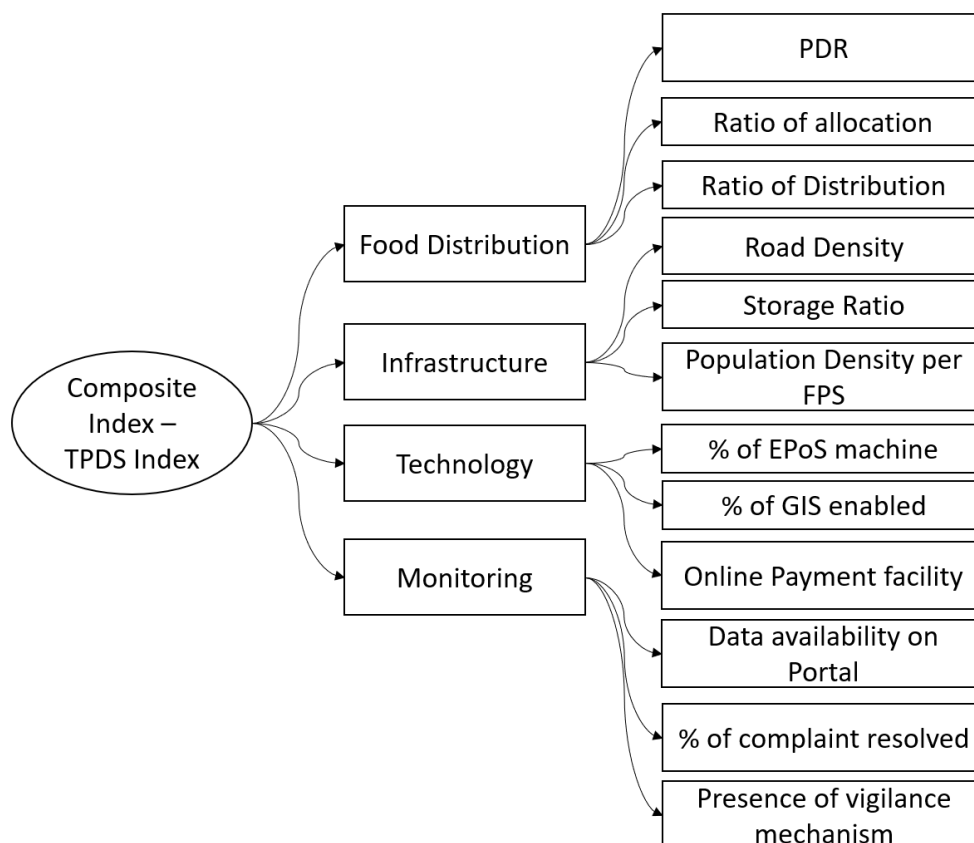


Figure 3.1 Selection of Parameters

3.1.2 Selection of Parameters

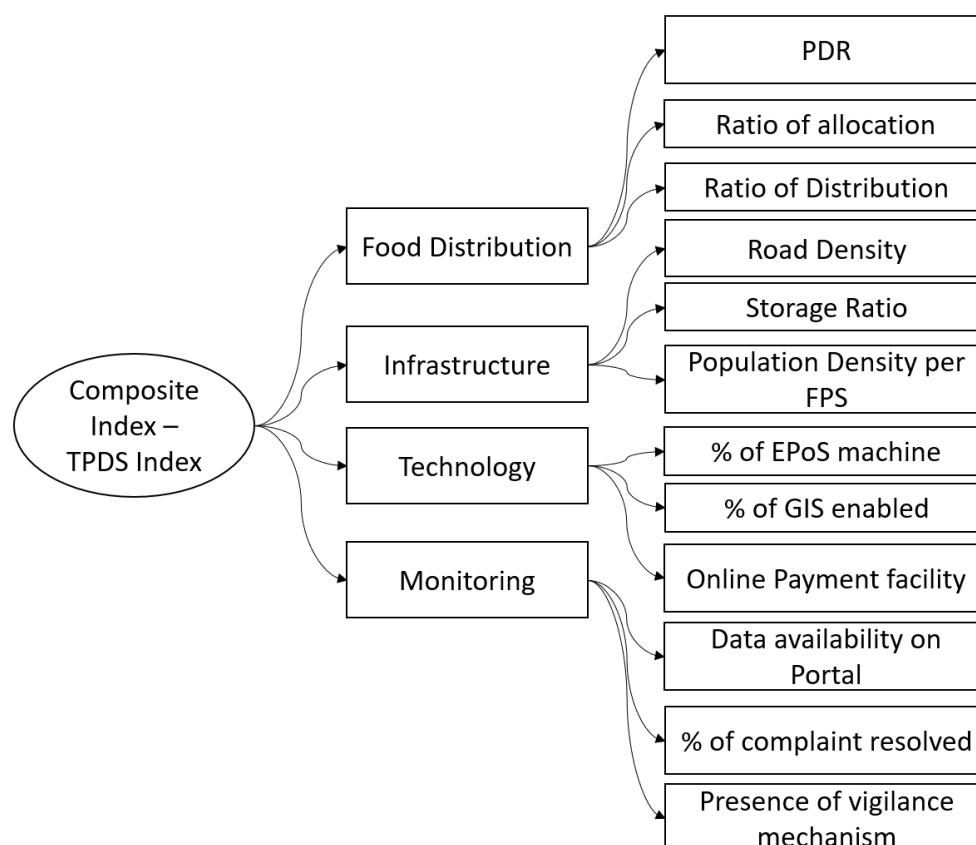


Figure 3.1 is the schematic representation of different parameters selected for this research from literature review and expert opinion. A composite Index named the TPDS index is calculated by four main pillars: food distribution, Infrastructure, Technology, and Monitoring. The parameters are carefully selected from various articles and research reports. The description of each parameter is given below.

Public Distribution Ratio (PDR): The arithmetic ratio of total beneficiaries (APL+PHH+AAY) to the total number of FPS. If the Public distribution ratio is less, the penetration and the working of FPS is smoother. If the values are high, then it is not penetrated to the entire households (Kokane et al., 2021)

Ratio of Allocation: The ratio of the total amount of foodgrains allocated to the total amount of foodgrains required by a particular area at a specific time. If the ratio of allocation is one or more than one, that implies the allocation of food grains is enough for serving the total beneficiaries as per the government norms (Kavita, 2014).

Ratio of Distribution: The ratio of the total amount of foodgrains distributed to the total amount of foodgrains required by a particular area at a particular time. If the ratio of

distribution is one or near to one means, the distribution of food grains is efficient, and all the beneficiaries take away their entitlement of food grains properly (Kavita, 2014).

Km of Road per 100 SqKM (Road Density): The availability of road network (in KM) of the 100 SqKm area. If the value is high, the transportation of food grains from the storage facility to FPS and the accessibility of food grains by the beneficiaries will be increased (Sarkar, 2019).

Storage Ratio: The ratio of total storage facility available for a particular area to the number of cardholders. If the value of this ratio is high, it implies the storage facilities can hold enough food grains for the beneficiaries at any time (Kokane et al., 2021).

Population Density Per FPS: The ratio of FPSs to the population density of a region at a specific time. It denotes how many people get benefit from an FPS in a KM of area.

Percentage of EPoS machine: Percentage of number of FPSs having EPoS machine. It describes the modernisation of the TPDS.

Percentage of GIS mapped FPSs: Percentage of number of FPSs mapped with GIS technology. It will help to improve the monitoring and evaluation. It also helps apply routing algorithms to find out the efficient delivery path and tracking of delivery in real-time.

Online Payment facility: Percentage of FPSs with online banking facilities. It helps to the monitoring and auditing make easy.

Data availability on Portal: It is a qualitative value that describes how much data is available in the TPDS portal, how accurate it is, how timely it will complete etc (Gupte & Doctor, 2021).

Percentage of Complaint Resolved: The percentage of complaints resolved by the grievance cell of TPDS of a particular region. Higher values indicate better monitoring and performance of the system (Gupte & Doctor, 2021).

Presence of vigilance mechanism: The presence of a vigilance mechanism to monitor the proper execution and take action against malfunctions in the system. The presence of such a system will reduce the errors and improve the throughput of the entire TPDS (Gupte & Doctor, 2021).

3.1.3 Calculations

Each main category holds equal weightage for calculating the Index. The values of each parameter are taken from different sources such as Government reports, official websites, census reports and GIS resources. The values will be normalised using standard (z values) normalisation to convert into normalised values to easily perform the calculations and comparison. The formula used to normalise is given below.

$$Z = \frac{x_i - \mu}{\sigma}$$

Where K_i is a normalised parameter, x_i , x_{min} , and x_{max} are value to be normalised, minimum value and maximum value of parameters. Here the i denote each Taluka of Palghar district.

$$TPDS\ Index = \sqrt[4]{I_{Food\ Distribution} * I_{Infrastructure} * I_{Technology} * I_{Monitoring}}$$

The above equation is used to calculate the TPDS index. For that, the Index of each main pillar will calculate and apply geometric mean like the calculation of the Human Development Index.

3.1.4 Timeline

The research timeline is also provided in Table 3.2, which provides the information about the sub-questions and the time taken for covering the sub-tasks.

Table 3.2 Project Timeline

Work to be done	Date
Field visits and data collection	27 Nov-20 Dec 2021
Analysis of collected data	1 Dec - 22 Dec 2021
Completion of first RO	01-Jan-22
Report submission	10-Jan-22
Mid progress presentation	17 Jan -20 Jan 2022

Completion of Second RO	28-Feb-22
Submission of report	10-Mar-22
Final Presentation	27 Mar to 31 Mar 2022

3.2 Study Area

Palghar is a nearby district performing below average performing in mapping and an average performer in terms of number of FPSs, PDR and Population/FPS. Due to the COVID pandemic, restriction on travelling and accessing the resources of other rural districts of Maharashtra is quite difficult for the research. 86% of the total villages of Palghar district fall under the Scheduled village category. The study will enlighten the working of TPDS in scheduled areas, and a detailed comparison of performance with TPDS of the normal area is possible in future. The basic information about the Palghar district is given in Table 3.3.

Table 3.3 Basic information of Palghar

Source: Created by the author from various resources.

Basic Information	
Taluka	8
Number of Vilalges	1008
No of Cities	10
Villages in Scheduled area	876
Villages in Scheduled area	132
Total Population	2990116
Rural hospitals	10
Sub-district hospitals	2
PHCs	46
Primary health unit	305
Total FPS	1084
Total KM of road	3310.32

Tota Area(SqKm)	5583.08
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3.3 Data Collection

The secondary data is collected from various sources such as government reports, circulars, scholarly articles, websites of various government departments and Information Management Systems(IMS). The list of the websites used to collect different information is given in Table 3.4. Several field visits and interviews with District Supply Officer, Palghar were done to get an idea about the TPDS and its working. The semi-structured questionnaire used to interview District Supply Officer is provided in Appendix III. The data collected from the field visit include both qualitative and quantitative. The collected data is used for quantitative as well as qualitative analysis. Geo sensitive data such as the area of the Taluka, roads etc., were fetched from maps using QGIS software.

Table 3.4 List of websites

Sr No .	Web URL	Information available
1	https://annavitrn.nic.in/welcome	Details of food grains delivered to the beneficiaries
2	https://nfsa.gov.in/	Details about NFSA, FPS, Central and state allocation, and distribution
3	http://mahaepos.gov.in/	Details of food grains delivered by Maharashtra
4	http://controllerofrationing-mumbai.gov.in/	Information related to food taking away from 2017
5	http://mahafood.gov.in/website/english/home.aspx	Information related to NFSA
6	https://nfsa.gov.in/State/MH	Various information about TPDS of Maharashtra state

Chapter 4

Evaluation of TPDS at Palghar District

Palghar district was formed on 1 August 2014 from Thane district, and it is the 36th district of Maharashtra. The total population is 29,98,425, and most live in villages. There are 1007 villages spread across 407 Gram panchayaths. The district is divided into eight taluka – Jawhar, Makkada, Talasari, Vassai, Vikramgad, Palghar, Dahanu and Wada (*District Palghar, Government of Maharashtra / District Palghar / India, n.d.*).

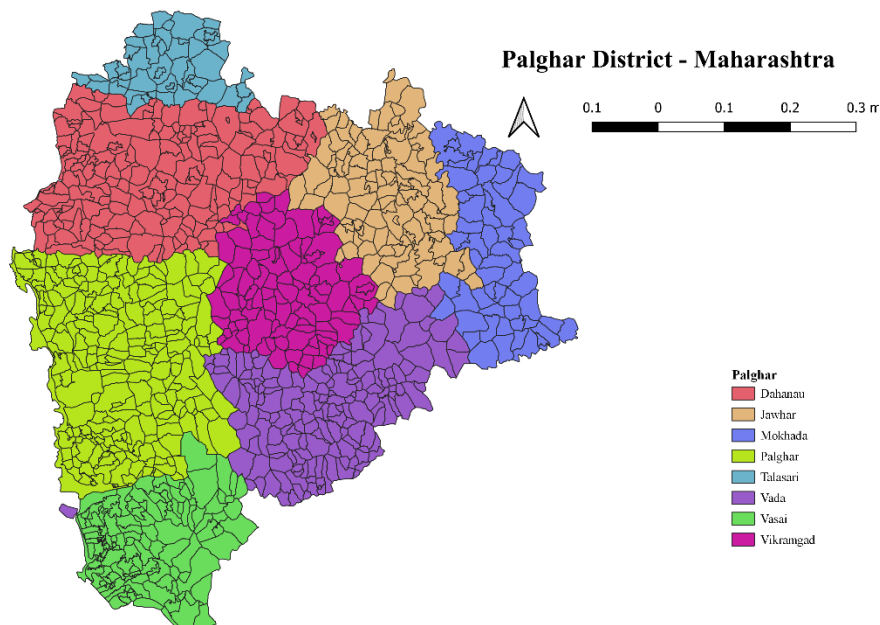


Figure 4.1 Palghar District

Figure 4.1 shows the villages and Taluka of Palghar district. Palghar is the largest Taluka and Talasari is the smallest Taluka. 37.4% of the district's total population, all under the ST category. 91.8% of the ST population lives in Vikramgad (Ghosh & Varerkar, 2019). Palghar district is known for malnutrition and other health-related issues.

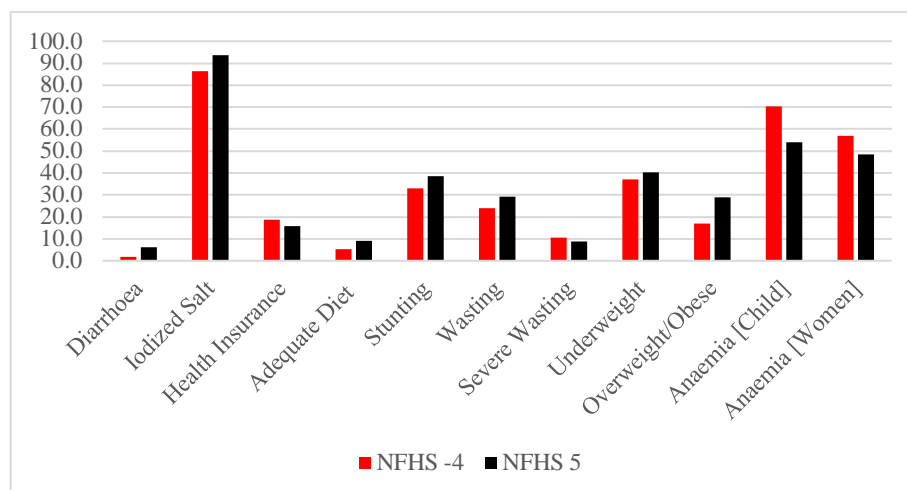


Figure 4.2 Health-related issues at Palghar District

Figure 4.2 **Error! Reference source not found.** shows the points for different health-related parameters considered for the study by National Family Health Survey 4 and 5. With the help of APJ Abdul Kalam Amruta Yojana – a programme developed by the Maharashtra government to provide nutritious foods to pregnant women and lactating women, Integrated Child Development Scheme (ICDS) etc. helped to improve the status of health care (Ghosh & Varerkar, 2019), but the change is minor. From NFHS 4 to NFHS 5, many parameters like Anaemia in children and women are slightly reduced.

There are 1048 FPS available in the Palghar district. As per the state data portal, all the FPSs have the facility for Road step delivery, and it implies all the FPSs are located near any kind of road. As a part of the Strengthening and modernisation of TPDS under End End computerisation of TPDS operation, all the FPSs in Palghar successfully implemented Aadhar enabled Targeted Public Distribution System.

Each FPS is controlled by an Assistant Food Security Office (AFSO) at the Taluka level. There are 8 AFSO available in the district. More than 1.70 lakh families are getting benefits from the TPDS in the district. Out of them, 35,332 families hold AAY cards, 1,42,178 families have PHH cards, and 1,64,312 households have APL cards as per the Maharashtra FPS portal.

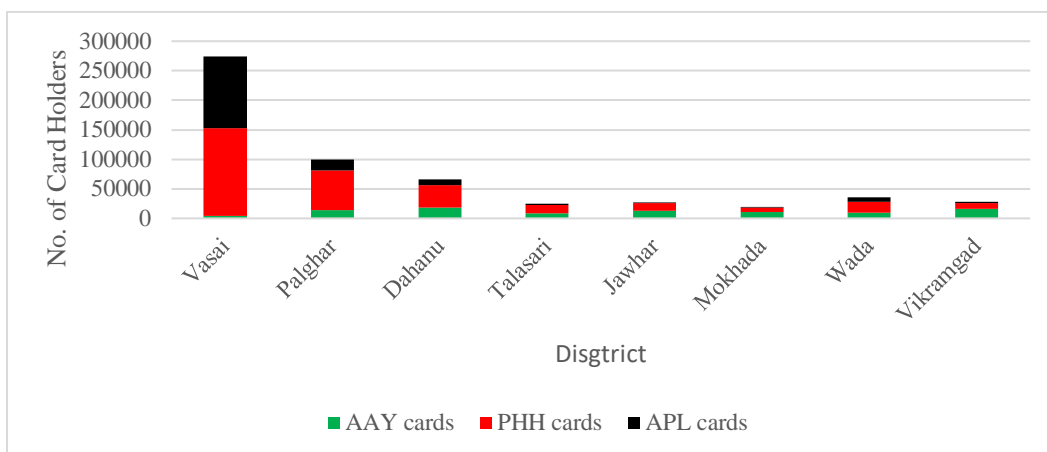


Figure 4.3 Distribution of Cardholders

Figure 4.3 shows the % of different cardholders across different Taluka of Palghar district. Vasai has the highest number of APL cardholders, consisting of 44% of total cardholders. Vikramgad and Mokhada have the highest number of AAY cardholders and account for more than 50% of total cardholders. Mokhada, Jawahar, Talasari, and Vikramgad have the highest percentage of NFSA beneficiaries (combined both AAY and PHH) – 90% of the cardholders fall into the AAY or PHH category.

4.1 Food Distribution

Allocation and distribution of food grains, requirements of food grains, availability of FPSs to serve the beneficiaries etc., have important roles in the performance of TPDS. Ratio of distribution, the ratio of allocation and PDR calculated and analysed using GIS. The results are described below.

4.1.1 Ratio of Distribution and Ratio of Allocation

Through TPDS, the Government is majorly distributing subsidised Wheat and Rice. Coarse grains are also distributed at a price of 1Rp/Kg. The details of food grains distribution are adequately maintained and monitored in the Annavitran portal (<https://annavitran.nic.in/>) by the Department of Food and Public Distribution, GoI. The portal retains the data from 2017. It provides data of allocation and distribution of Rice, Wheat and coarse, number of FPS, number of AAY and PHH cardholders and % values of the distribution.

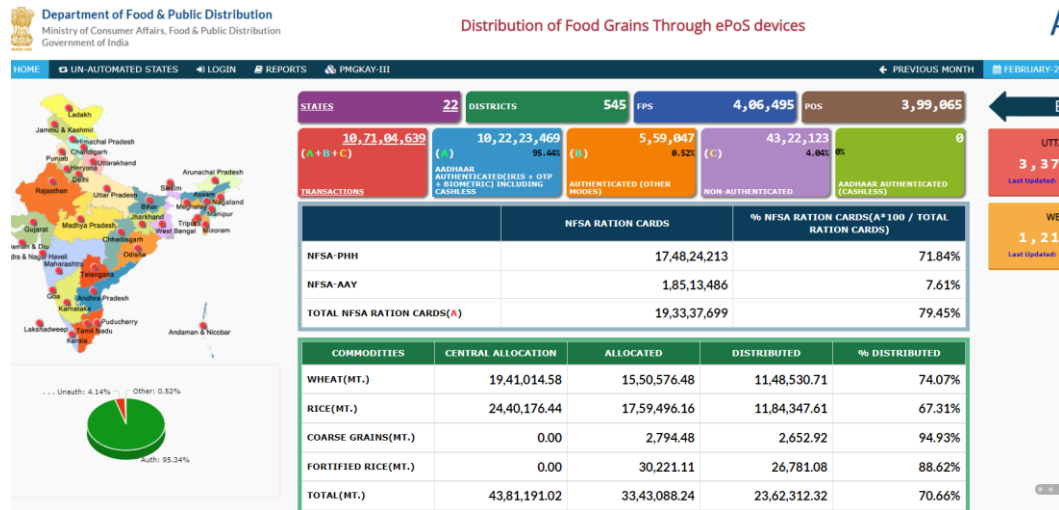


Figure 4.4 Annavitran Portal

Figure 4.4 is a screenshot of the Annavitran portal developed by GoI to monitor the performance of TPDS in terms of allocation and distribution of food grains.

In 2018, 40037.23 Metric Ton of Wheat and 69459.37 Metric Ton of Rice were allocated to the Palghar district. The amount, of course, is minute and not considered for the studies. Thus, the total allocated food grains are added to 1,09,496.6 Metric Ton. Out of that, 84,325.8 MT of foodgrains was distributed. There are no details about the remaining 25,170.8 MT food grains. Similarly, in 2019, the total amount of allocated food grains (including Rice and Wheat) was 1,10,854.9 MT and distributed is 97,872.57 MT. In 2020, total amount allocated is 1,21,656.4 MT and distributed is 1,02,185.21 MT. The details are tabulated in Table 4.1.

. The trend of allocation and distribution is positive, but even though there is a massive amount of food grains not reached to the beneficiaries and is referred to as diversion or leakage. It may be due to various reasons such as storage and transportation losses, leakage due to corruption and losses due to spoilage(Khera, 2011).

To calculate leakage, the following algebraic formula is used (Paul, 2016). Leakage was reduced in 2019 from 23% to 12 % while increasing in 2020 to 16%.

$$Leakage_{year} = (Total\ Allocated_{year} - Total\ Distributed_{year}) / Total\ Allocated_{year}$$

Table 4.1 Allocation and Distribution of Food Grains

Source: <https://annavitran.nic.in>

Year	Total Grains allocated (MT)	Total Grains distributed (MT)	Difference (MT)	Leakage
2018	1,09,496.6	84,325.8	25,170.8	23%
2019	1,10,854.9	97,872.57	12,982.33	12%
2020	1,21,656.4	1,02,185.21	19,471.19	16%

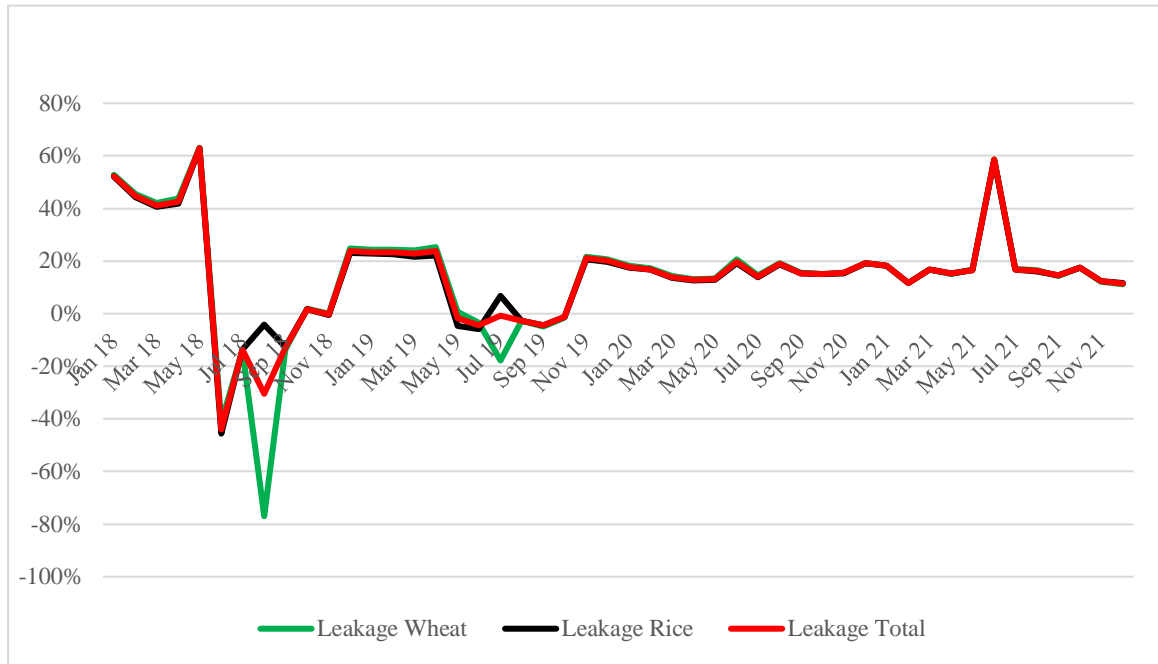


Figure 4.5 Leakage of food grains, 2018-2021

Figure 4.5 is demonstrated the leakage of Rice and Wheat during January 2018 to December 2021 of Palghar district. The data is obtained from the Annavitran Portal applied the equation mentioned above. In January 2018, the overall leakage was 52% and in May 2018 it reached the overall high value of 63%. In 2018 and 2019, there is a negative leakage reported during June to September months, which is normally monsoon time. But the same trend was not followed during 2021, and surprisingly, the leakage was highest in June 2021, and the value was equal to 59%.

According to the Table 1.1, the required amount of food grains for a month is mathematically calculated as

$$Total\ Foodgrains_{Required} = \frac{((n_{AYY} \times 35) + (N_{PHH} \times 5))}{1000}$$

Where,

$$n_{AYY} = \text{Total number of AAY Households}$$

$$N_{PHH} = \text{Total number PHH household members}$$

Two more parameters were introduced to understand the relationship between food grain allocation and distribution, such as the Ratio of allocation and the Ratio of Distribution. The equations are given below.

$$\text{Ratio of allocation} = \frac{\text{Total Foodgrains}_{\text{Allocated}}}{\text{Total Foodgrains}_{\text{Required}}}$$

$$\text{Ratio of distribution} = \frac{\text{Total Foodgrains}_{\text{Distributed}}}{\text{Total Foodgrains}_{\text{Required}}}$$

District wise Ratio of allocation and Ratio of Distribution

The yearly value of the Ratio of allocation and the Ratio of distribution of the Palghar district is calculated and tabulated in Table 4.2. The ratio of allocation of 2018 is incomplete because of the unavailability of the data. The data of cardholders of the Palghar district is available from June 2018. The allocation ratio is improving from 2018 to 2020, and allocation is crossed more than the required amount of food grain in 2021. But the ratio of distribution is not yet achieved one and is lagging. From this, it is clear that the total required amount of food grains is not distributed to the beneficiaries and needs to improve the TPDS.

Table 4.2 Ratio of allocation and Ratio of distribution

Source: <https://annavitran.nic.in> & <http://mahaepos.gov.in/>

Year	Total Food grain required	Total Food grain allocated	Total Food grain Distributed	Ratio of Allocation	Ratio of Distribution
2018 ¹	78349.56	51256.97	54479.47	0.654209	0.695339
2019	127661.7	110854.9	97872.57	0.868349	0.766656
2020	121702	121656.4	102185.2	0.999626	0.839635
2021	124480.3	136480	106568.6	1.096398	0.856108

¹ From June 2018 to December 2018

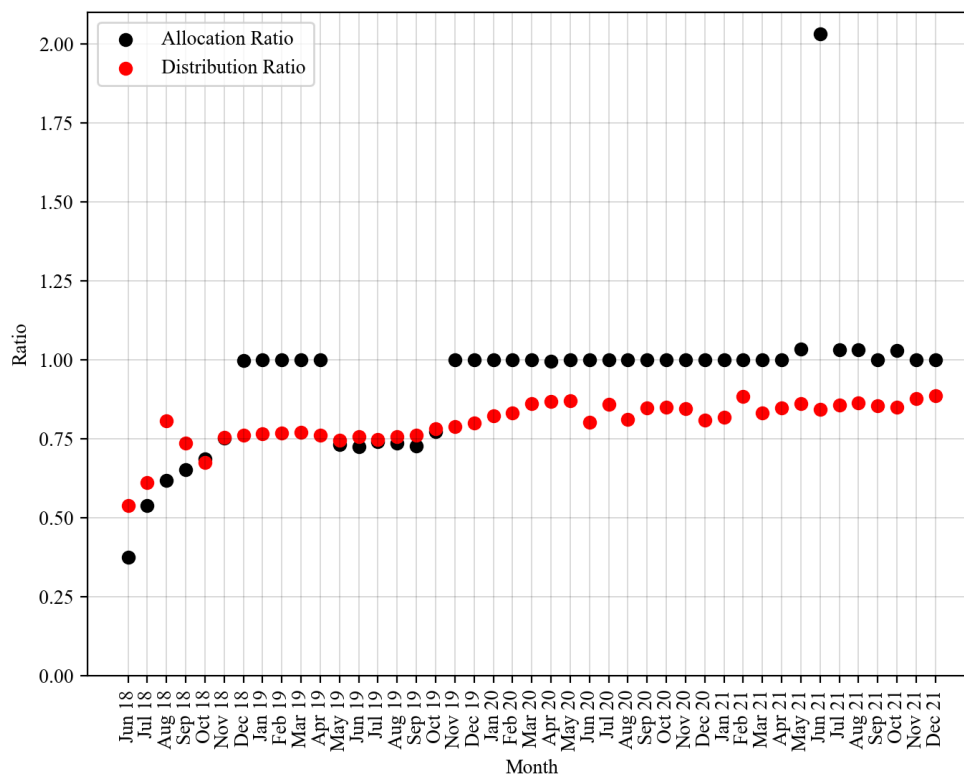


Figure 4.6 Ratio of Allocation and Ratio of Distribution

The two ratios Palghar district from June 2018 to December 2021 is plotted in Figure 4.6. Most of the months, the allocation ratio is aligned with 1, which means the allocation of food grains is equal or greater than the requirement of food grains. After complete computerisation of TPDS, the allotment became more accurate than early months of computerisation (June 2018). The distribution ratio never touches 1, and there is a clear gap between food grain distributed and food grain required.

Taluka wise analysis

The data provided by the district supply office, Palghar, gives an insight into the Taluka level distribution and allocation of food grains. Wheat, Sugar, Toor, Urad, Chana, Rice and Palm oil are distributed through the TPDS system. But compared to the quantity of Rice and Wheat, others were distributed in less amount and not considered for the study.

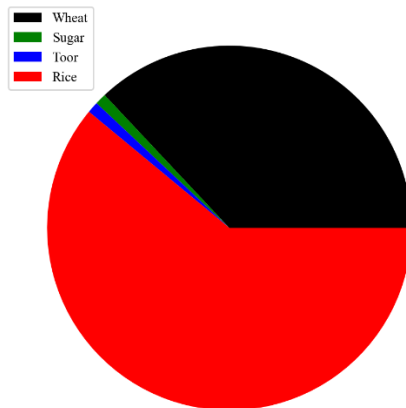


Figure 4.7 Availability of Foodgrains

As per the last three-year data of foodgrains distributed through FPSs, 37% was Wheat, and 61% was Rice. Other grains contribute only 2%. The Figure 4.7 demonstrates the above statement.

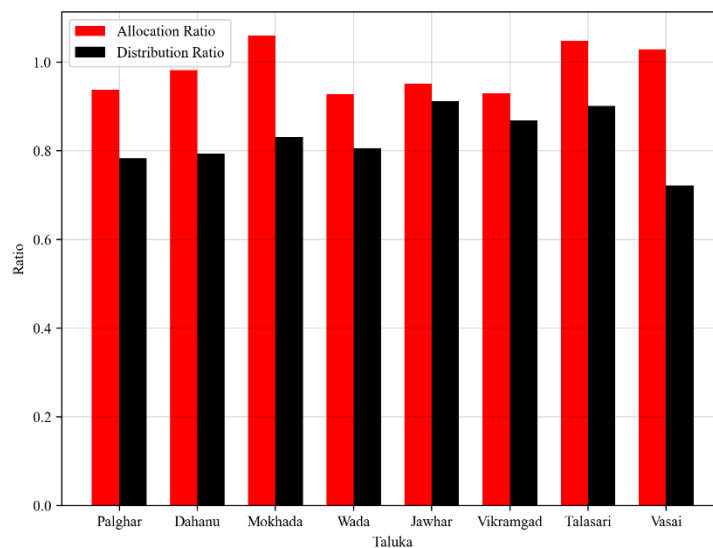


Figure 4.8 Taluka wise Allocation and Distribution Ratio

Figure 4.8 shows the comparison of the ratio of distribution and ratio of allocation in different Taluka of the Palghar district. The ratio is calculated by the arithmetic mean values of last four years. The overall trend is followed in Taluka levels as well. The ratio of allocation is always high, which is nearly equal to one, while the distribution ratio is below

0.9. The average ratio of distribution is 0.82, and the average ratio of allocation is 0.98. The allocation and distribution ratio gap is very high at Vasai, Mokhada, Dahanu and Palghar. In Jawhar and Vikramgad, the gap is less compared to other Talukas.

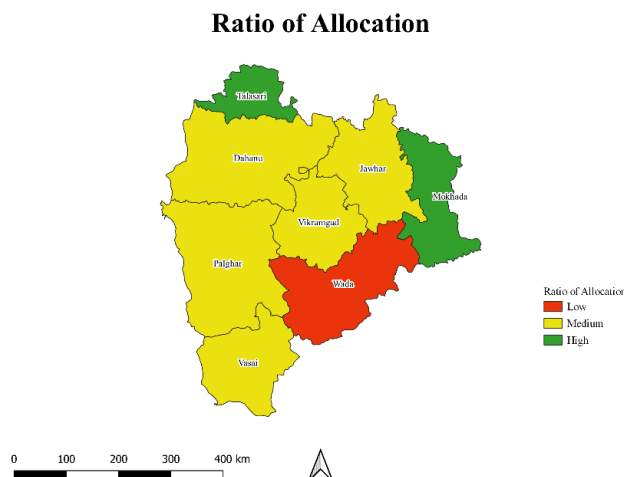


Figure 4.9 Ratio of Allocation of Different Talukas

Figure 4.9 shows the ratio of allocation of different Talukas of the Palghar district. The values are calculated by taking arithmetic mean of last four years. The values less than first quartile (below 0.9) considered as low and higher than third quartile (1.03) considered as high. Wada is the only one Taluka performs low. Mokhada and Talasari perform under high category. Overall, the allocation of foodgrains at all Taluka is nearly one.

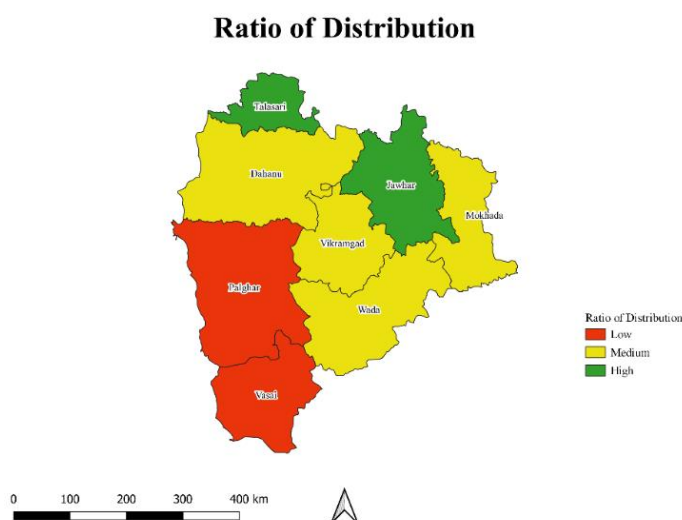


Figure 4.10 Ratio of Distribution of Different Talukas

Figure 4.10 demonstrate the Taluka wise Ratio of distribution in the map. The Talukas are divided into three category such as low (0-0.79), medium (0.80-0.87) and high (above 0.87). Vasai and Palghar fall under low category and others are performing better than these Talukas. Both the Talukas are near to Mumbai and more urbanized.

4.1.2 Public Distribution Ratio

Public Distribution Ratio calculated using the total number of beneficiaries per FPS. PDR is calculated by dividing the total number of beneficiaries (AAY+ PHH+ APL) by the total number of FPSs available in a particular region. PDR is provided information related to the number of households served by an FPS. Lower PDR indicated the efficiency of working of FPSs and helped to penetrate the benefits of TPDS to all the beneficiaries of the area(Kokane et al., 2021). Dahanu Taluka is enjoyed the least PDR of 94.31, and Mokhada has the highest number of PDR – 4277.34, which is ten times more than the guidelines provided by the GoI. Vasai, Palghar, Dahanu, Jawahar, Wada and Vikarmgad falls under a PDR of 400, which is provided in the guidelines by the Department of Public Distribution. Talasari and Mokhada have scored more than 1000, which much more than the guidelines provided by Maharashtra Government. As per the guideline 400-500 is the ideal value for PDR in rural areas and 1600-1500 is ideal PDR for urban areas.

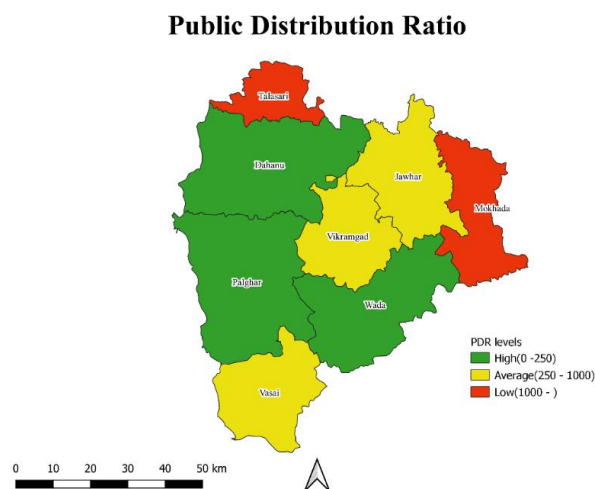


Figure 4.11 Public Distribution Ratio of Palghar District

Figure 4.11 shows the PDR across different Taluka of Palghar district. Three talukas fall into High (0-250), and three fall into the Average (250-1000) category. 2 Falls into Low (more than 1000). The PDR is showed some pattern, and the Talukas far from the urban area are performing poorly in terms of the number of FPS per beneficiaries.

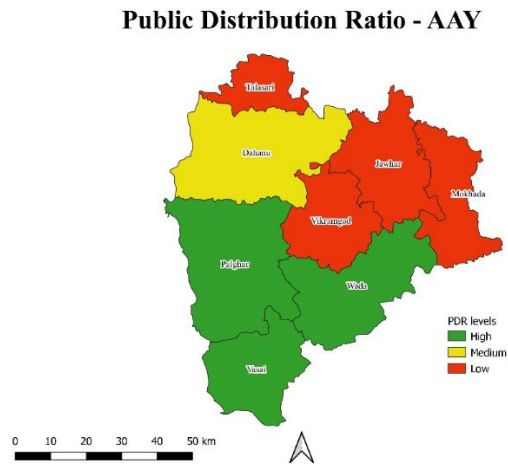


Figure 4.12 Public Distribution Ratio for AAY

Figure 4.12 is described the number of FPS for serving the AAY beneficiaries. The whole district is divided into three as High (0 -75), Medium (75 -125) and Low (More than 125). The western part of the district performs well since the number of AAY cardholders is less, while the eastern part contains more AAY cardholders, and the ratio is high.

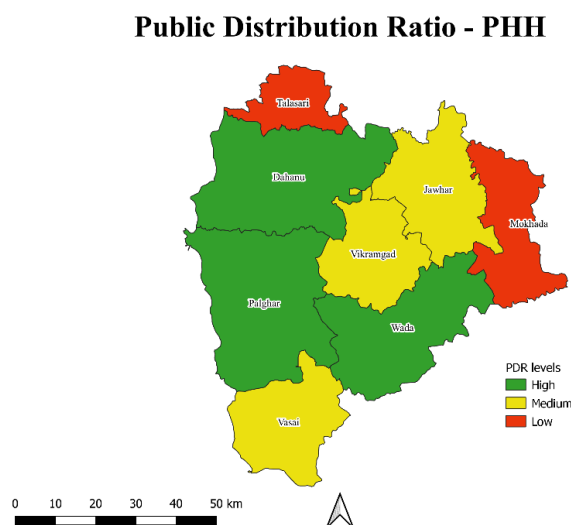


Figure 4.13 Public Distribution Ratio PHH

Figure 4.13 visualises the PDR for PHH. The ratio is divided into three categories High – up to 90, Medium 90-400 and Low -above 400. The distribution ratio follows the trend of the total PDR shown in Figure 4.11.

4.2 Infrastructure

Storage facilities, FPSs and transportation facilities are the most important infrastructures to run TPDS. These parameters are identified and analysed. The results as follows.

4.2.1 Storage Facility of Foodgrains in Palghar District

There are majorly three storage facilities set up by or hired by FCI to distribute food grains to the Palghar district. FSD Borivali, FSD Bhiwandi, and CWC Vashi are those three storage facilities and have a storage capacity of 1,55,446 MT (*Storage - Food Corporation of India*, n.d.).

Palghar district has 23 godowns, totalling a capacity of 9450 MT to store TPDS food grains located at each Taluka owned by the state government (Kokane et al., 2021). The number of godowns and the total capacity of godowns for each Taluka is given in Table 4.3.

Table 4.3 Godowns available at each Taluka

Taluka	No. of Godowns	Capacity (Metric ton)
Vasai	4	2000
Palghar	4	1750
Dahanu	3	1500
Talasari	2	750
Jawhar	3	850
Mokhada	3	750
Wada	3	1500
Vikramgad	1	350
Total	23	9450

Table 4.4 shows the different calculations based on the total number of cardholders (AAY+PHH+APL), number of FPS and population. The cardholders' and FPS data are obtained from the Maharashtra TPDS portal, and population data is obtained from census 2011. The storage ratio is calculated by finding the arithmetic ratio of total storage capacity to

total cardholders. Vasai has the highest storage ratio (145.5), while Mokhada has the least storage ratio (4.65).

Storage per FPS is another indicator showing the efficiency of the storage facility of TPDS. Vasai, Talasari and Mokhada have more than 10,000 Kg food storage facilities per FPS. The value of Mokhada is high because of the presence of less number of FPS(64).

Table 4.4 Analysis of Storage facilities

Taluka	Godowns	Capacity(Metric ton)	Storage ratio = Total storage capacity/Total Card holders(KG)	Storage/FPS (KG)	Population	per capita storage(KG) =Capacity/Population (KG)
Vasai	4	2000	145.5013	11111.11	1343402	1.488758
Palghar	4	1750	87.89355	7990.868	550166	3.180858
Dahanu	3	1500	69.88121	7246.377	402095	3.730462
Talasari	2	750	23.65441	10869.57	154818	4.844398
Jawhar	3	850	50.91636	8854.167	140187	6.06333
Mokhada	3	750	4.652655	11718.75	83453	8.987095
Wada	3	1500	50.81923	9554.14	178370	8.409486
Vikramgad	1	350	36.08201	3804.348	137625	2.543143

Storage facility per Card holders

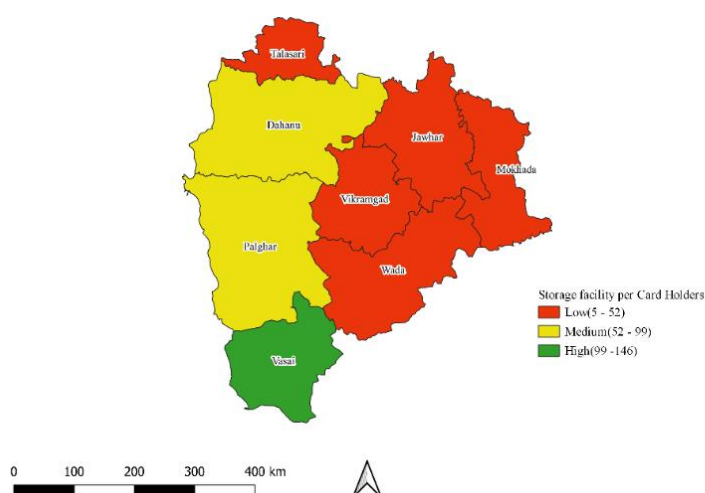


Figure 4.14 Storage facility per Cardholders

Figure 4.14 shows the special distribution of storage ratio (Storage facility per cardholders). The urban regions showed better performance than other regions. Vasai, Palghar, Dahanu obtained better values from 52 Kg to 146 Kg per cardholder. But the other five talukas obtained below 52 Kg per cardholder.

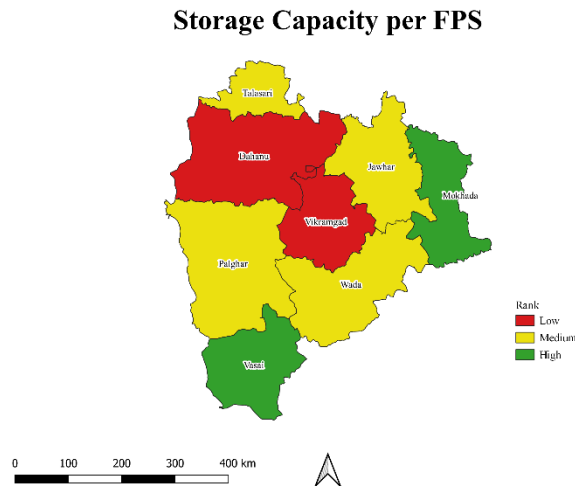


Figure 4.15 Storage facility per FPSs

Figure 4.15 demonstrates the storage facility per FPSs values. Here also, the talukas near to urban centres performed well. Eastern parts of the districts seem to be performing well because of fewer FPSs. The district officials informed that there is less facility at Vikramgad due to the geographical speciality of the region, and hence they are utilising the neighbouring Talukas' facilities.

4.2.2 Road Network

The transportation network is highly connected with the development of the region. It has a vital role in all aspects of human life. Without a sound transportation system, goods and services cannot be reached to the area's people at a sufficient quantity (Oluwaseyi, 2018). Palghar district has 3310.32 Km of road network consisting of National highways, state highways and other small highways as per the OSM road network spatial data.

Road Network

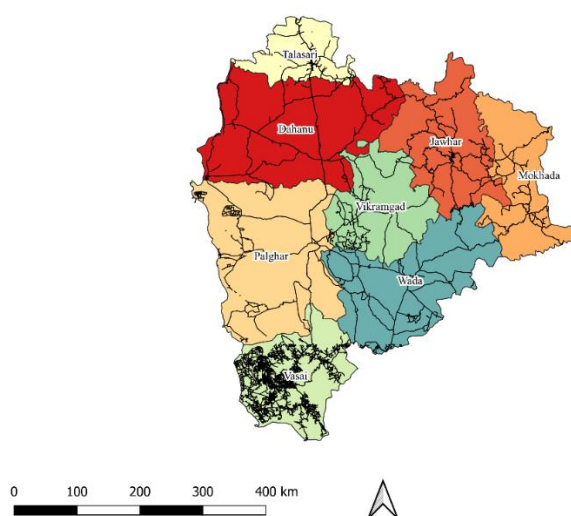


Figure 4.16 Road network at Palghar district

Figure 4.16 shows the road network of Palghar district. Talasari Taluka has the least road network of 153.8Km and Vasai has the highest road network – 1468.84 Km. Road density is the Km of roads available per 100 SqKm. Palghar has the least road density, while Vasai has the highest road density. The district average is 45.33 Km/100SqKM. Table 4.5 shows the details of the road network in the Palghar district at the Taluka level.

Table 4.5 Road network information of Palghar district

Source: OSM data

Taluka	Number of Roads available	Total KM of road	Road Density(Km /100SqKm)
Palghar	248	209.04	19.39758365
Dahanu	240	342.11	32.07632085
Mokhada	123	196.18	37.1327983
Wada	198	368.28	44.67303097
Jawhar	148	307.51	45.99036851
Vikramgad	227	264.54	48.80451627
Talasari	157	153.82	53.19546272
Vasai	3264	1468.84	250.5184882

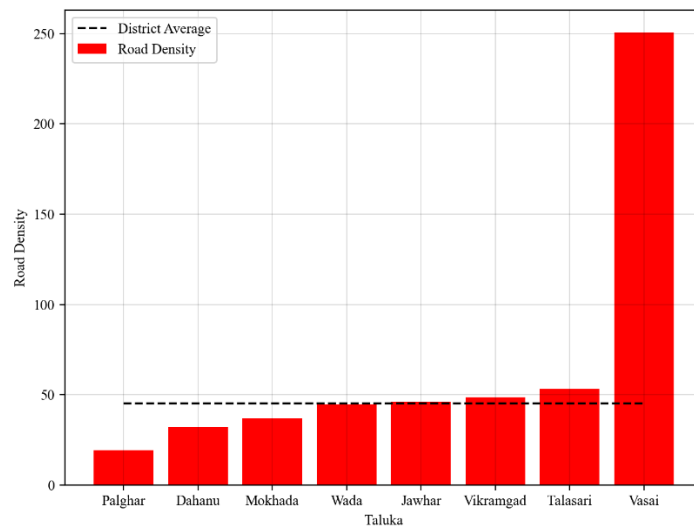


Figure 4.17 Road density at Palghar district

Figure 4.17 shows the road density at different Taluka. Palghar, Dahanu, Mokhada and Wada districts have less road density than average road district road density(45.33 Km/100SqKm) while Talasari and Vasai have high road density. The presence and urban areas and neighbourhood of Mumbai helped Vasai to get higher road density.

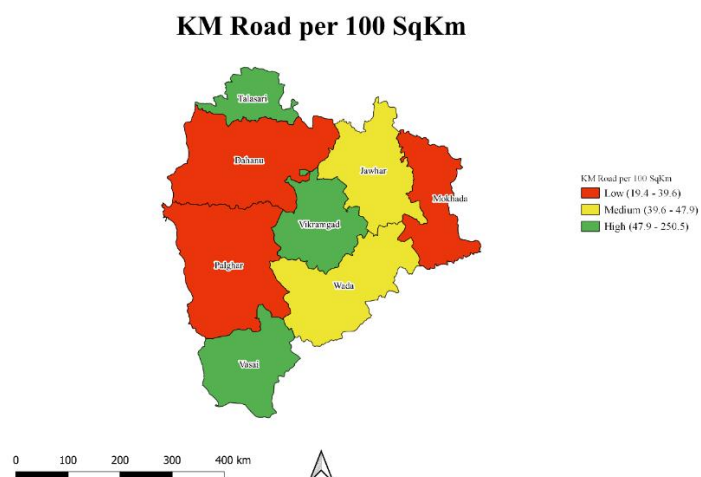


Figure 4.18 Road density

Figure 4.22 shows the spatial representation of road density. For analysis, the Taluka was classified into three equal quantiles. Out of eight Talukas, only three Talukas perform above the district average. The rest of the Talukas are performing very low. There is no specific geographic pattern observed. Vasai is adjacent to Mumbai, which helped to improve the road network. The availability of transportation facilities affects food distribution through TPDS.

4.2.3 Population Density per FPSs

The experts suggest this parameter. It is calculated by dividing the population density by the number of FPSs. It denotes how many people benefit from an FPS in an SqKM of area, simply how easy to access the FPS in an area by the population – number of population/people served by an FPS with in one SqKM. The area's population density is calculated using census 2011 data, and the area is fetched using the geospatial tool. The population density of the Palghar district is 535.56 people/SqKM area. In Palghar district, Mokhada Taluka has the lowest population density(157.96) and Vasai Taluka has the highest population density(2291.24) as per the calculations using the above parameters. Population Density per FPS varies with population density and the area of the location.

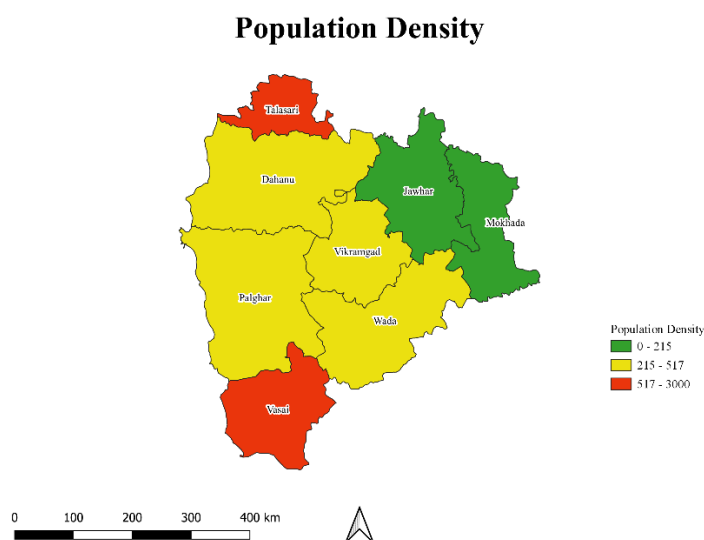


Figure 4.19 Population density of Talukas

Figure 4.19 visualise the population density in a map. Towards the East, the population density is very low and in Western side, the values for population density are high. The values of population density for Vasai, Palghar and Talasari are 2291.24, 510.5 and 535.4 respectively. In other places the value of population density is less than 500 per Km. If the population density is high, then a greater number of FPSs required in an area to serve the entire population.

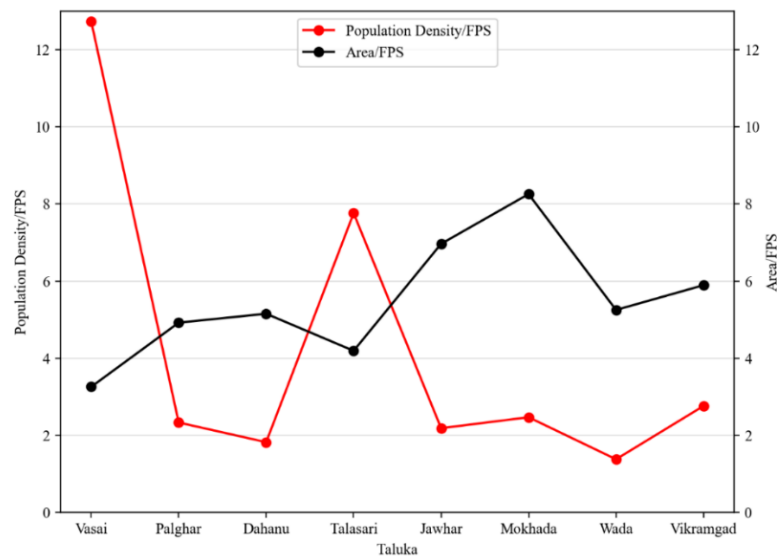


Figure 4.20 Population Density per FPS

Figure 4.20 shows the plotting of population density per FPS and Area per FPS. It demonstrates an inverse relationship between the two parameters. Where the population density per FPS is high, the value of Area per FPS is low and vice versa. Vasai (12.73) has the highest value for Population density per FPS, and Wada has the lowest (1.38). Area per FPS is calculated by dividing the total area of each Taluka by the number of FPSs available at each Taluka. It gives an idea about how much area is served by each of FPS in a Taluka. The FPSs of Mokhada serve 8.2SqKm while, The FPSs of Vasai serve only 3.5SqKM. If the value of population density per FPS is less, may affect the economic viability of the FPS and if the value is high, it will affect the penetration of TPDS to different category.

Population Density per FPS

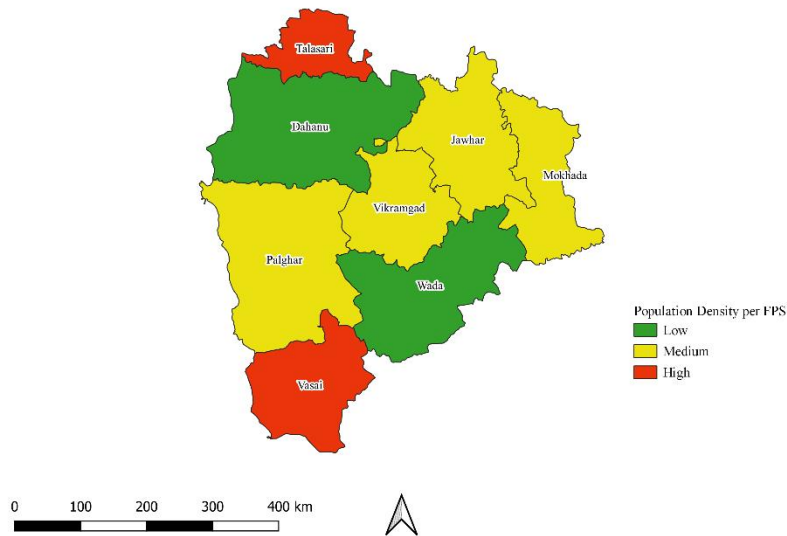


Figure 4.21 Population Density per FPS

The population density per FPS is mapped and shown in Figure 4.21. The entire values statistically classified into three categories as low (below 2.09), medium (2.1 – 4) and high (above 4). FPSs at Vasai and Talasari serve more people within 1 SqKM, which affect the penetration of TPDS. FPSs at Wada and Dahanu serve less people within 1 SqKM. The remaining Talukas fall between these four Talukas.

4.3 Technology

GoI gives importance to modernise the working of TPDS to reduce the error and for better performance. In that sense, GoI introduced end-to-end computerisation, Aadhar seeding, GIS mapping of FPS, Grievance redressal facilities and transparency portals, online allocation of foodgrains and national portability of ration cards. Some of the parameters to determine the performance of TPDS in Technology aspect is analysed and results are provided.

4.3.1 Percentage of GIS enabled FPSs

GIS mapping of FPSs will help to make an efficient strategic plan for distribution of food grains by analysing the travelling time, requirement of food grains, optimal routes to reduce the cost of transportation. It also helps in real-time monitoring of food distribution trucks using a centralised system(Ljungberg et al., 2013).

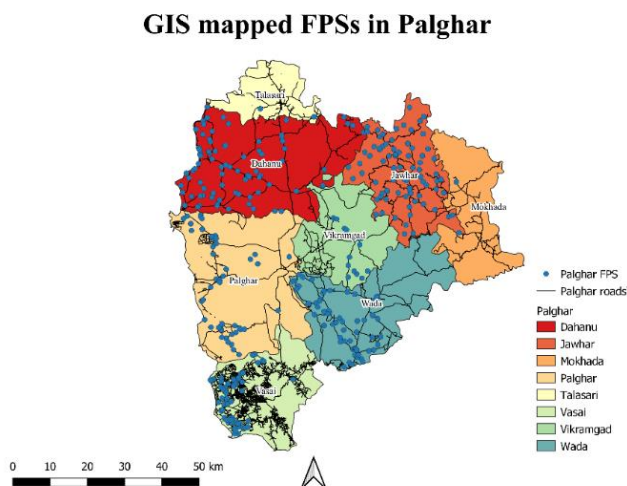


Figure 4.22 FPS distribution in Palghar district

Source: <https://nfsa.gov.in/public/nfsadashboard/PublicFPSDashboard.aspx>

There are 1048 FPS available in the Palghar district. But, out of that, only 431 are geo mapped and shown in Figure 4.22. As per the state data portal, all the FPSs have the facility of door-step delivery, which means the FPSs are located near the roads.

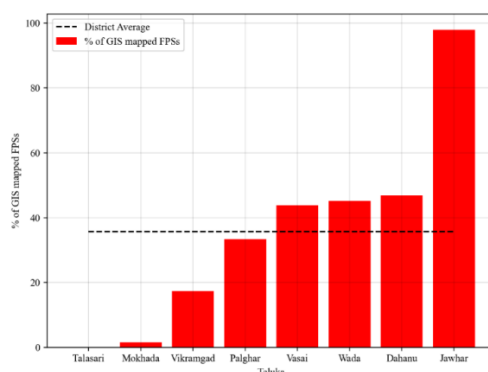


Figure 4.23 Percentage of GIS mapped FPSs

Figure 4.23 shows the distribution of percentage of GIS mapped FPSs of Palghar district. Talasari has 0% improvement in the GIS mapping of FPS. Jawahar completed 98% of GIS mapping, while others all fall into 33%-65% improvements. Overall, the district completed 35.77% of GIS mapping. The district officers claimed that FPS mapping is going on at various places. Lack of availability of internet, transport facilities, and technical labours are the main reason to decline the speed of FPS mapping.

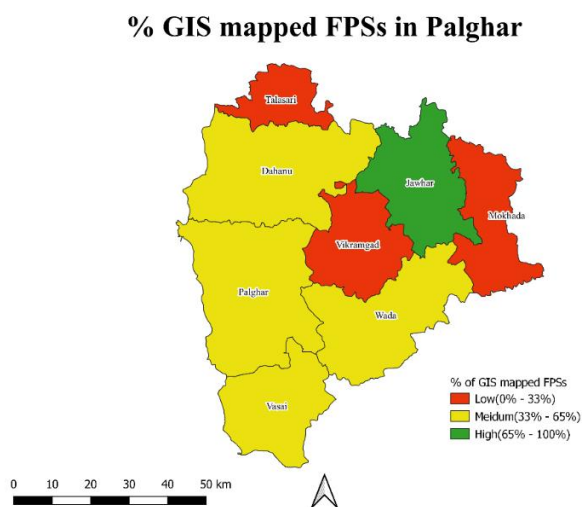


Figure 4.24 %of GIS mapped FPS in Palghar

Figure 4.24 represent the performance of Talukas in terms of the percentage of GIS mapped FPS in the Palghar district. As per the data provided by the GoI NFSA portal (<https://nfsa.gov.in/>),

4.3.2 Electronic Point of Sale (EPoS) Machine Availability

GoI introduced an electronic point of Scale in 2015 to enable end-end computerisation of TPDS. EPoS is a machine used at FPSs to read the biometrics of the beneficiaries (any family members of the cardholders/ nominated person in some particular cases). On approval, the allotment of food grains to beneficiaries is performed(Gupte & Doctor, 2021). The EPoS helps to reduce the stealing of food grains and the diversion. Also, it helped to manage the supply chain efficiently.

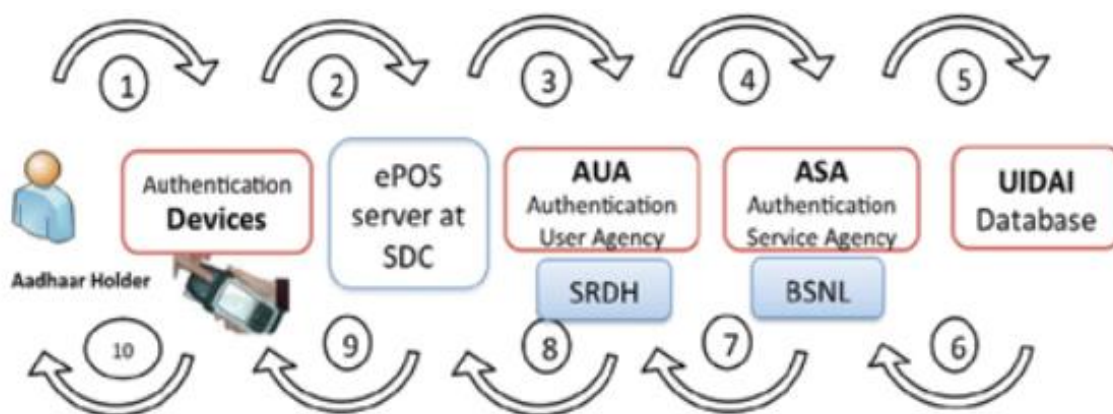


Figure 4.25 Working of EPoS

Source: <https://informatics.nic.in>

EPoS is working based on the Online Authentication Service provided by UIDAI. Figure 4.25 shows the working of EPoS. First, the EPoS machine will send a request to the PDS server with the ration card number, commodity, quantity, UID number and fingerprint. The PDS server is securely authenticated with UIDAI biometric database and responds with a success or failure message. If the authentication becomes a success, then the PDS server will update the beneficiaries' values of stocks and transactions. In the end, the success message will come to the EPoS machine and print the receipt containing commodity, quantity and price. The server has a portal that can be accessible by the public contain all the information related to the EPoS machine and transaction. This facility improved the transparency of the system.

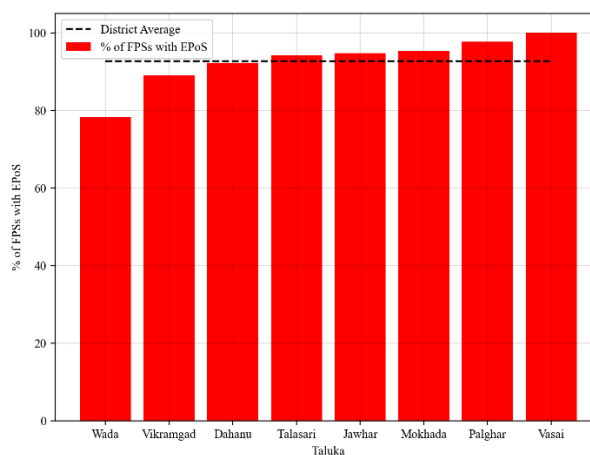


Figure 4.26 Percentage of FPSs with EPoS

Figure 4.26 shows the percentage of FPSs with EPoS. According to the district officials, 77 FPSs do not have EPoS due to lack of network and related issues and still using old offline methods. 92.89% FPSs are working (1077 out of 1084). Wada and Vikramgad have more number of FPSs without EPoS, and fall below district average. Vasai has achieved 100% installation of EPoS in all FPSs.

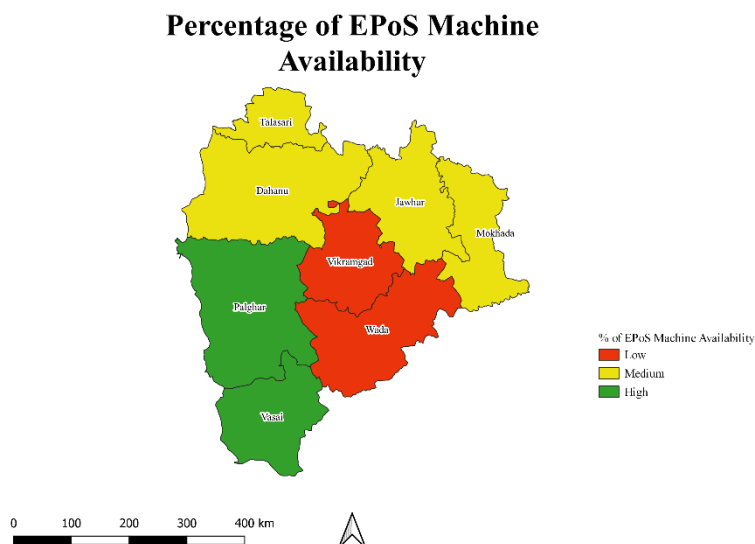


Figure 4.27 Percentage of EPoS machine availability

Figure 4.27 shows the spatial analysis of percentage of EPoS machine availability in the Palghar district. Vasai and Palghar have better availability of EPoS machine (more than 97%), while Vikramgad and Wada have less availability. Due to the physical and technological constraints, there is no EPoS machine available at Vikramgad Taluka. Other Talukas also not fully use EPoS machine due to lack of internet availability and related infrastructures.

4.3.3 Online Payment Facility

One line payment is an important technology advancement in TPDS. It helps to make more accountability of transaction. In many shops, mobile wallets and UPI based applications such as BHIM, GPAY, PAYTM are used to process the money transaction. The district officials informed that there were no FPSs in Palghar district use online payment facilities. But the officials are trying to implement the facilities to improve the working and efficiency

of the system. Even though the values are not available for Palghar district, it can be used as a parameter for other districts which have the online payment facilities.

4.4 Monitoring

Monitoring is an important pillar to evaluate TPDS system. Monitoring process helps to evaluate the performance, find the problems, measuring the efficiency of the resources and strengthening the overall TPDS. According to the District Supply Officer, there are two major mechanisms to monitor the system apart from grievance cell and transparency portals. The first one is consisting of the employees of TPDS – district level to the Taluka level randomly inspect the FPSs and godowns and make report to the higher officials. Each level employee has their own targets per months. The second one is a participatory mechanism which include the beneficiaries. A group of beneficiaries act as vigilance council at each village level and do the inspections and make the reports to the higher authority if there any issue found. The following parameters are used and results are given below.

4.4.1 Data availability on the portal

All the FPSs of all Taluka are updating their transaction information on transparency portal. The portal is available to public and can access various information like number of transactions, amount of grain served on monthly based or daily based, number beneficiaries up to FPS level etc. Presence of EPoS machine helps to update the information very accurately. According to the district officials, the FPSs which do not have EPoS also update the information manually on time. The value of Data availability is considered as one for all the Talukas.

4.4.2 Percentage of complaints solved

Grievance and resolving issues are one of the best way to make the a system efficient. Maharashtra government started an online platform and a mobile application to accept the complaints from people on various government programmes. The online platform is named as grievance redressal portal (<https://grievances.maharashtra.gov.in/en>) and mobile app is called ‘Aaple sarkar’. The people can register their complaints regarding services of different

departments like agriculture, energy, finance, food, civil supplies, industry, public work etc. through these initiatives. The Palghar district officials shared the information regarding complaints registered and resolved regarding TPDS and shown in the Table 4.6.

Table 4.6 Grievance redressal portal

Taluka	Complaint Registered	Pending	Resolved
Dahanu	40	6	34
Jawhar	5	0	5
Mokhada	4	1	3
Palghar	130	28	102
Talasari	2	0	2
Vasai	505	20	485
Vikramgad	15	11	4
Wada	25	13	12

Table 4.6 shows the total complaint registered from 2020, from which this portal is started. The complaints are received by different means such as letter, email, online portal, phone call, SMS, and personal visits. All the complaints have added to the portal for more accountability. The complainer can see the progress of complaints through the online portal.

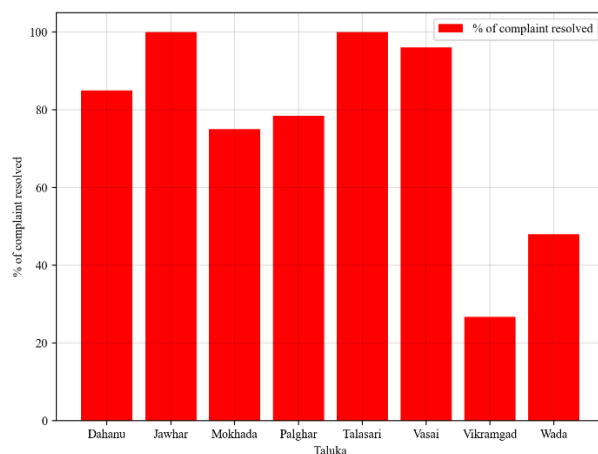


Figure 4.28 Percentage of Complaint redressal

The percentage of complaint resolved is calculated for 2020 and 2021 and plotted as shown in Figure 4.28. For Jawahar and Talasari, 100% complaints are solved during these years. While the % of redressal is less in Vikramgad and Wada, where the % fall below 50.

Percentage of complaints solved

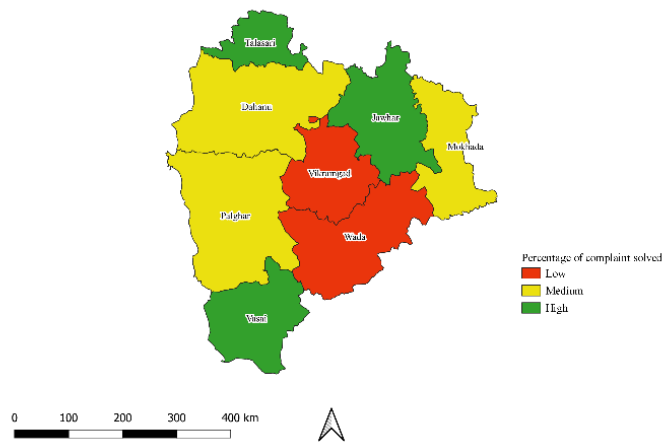


Figure 4.29 Percentage of Complaints Solved

The same thing is mapped and shown in Figure 4.29. The Talukas are classified into three categories as low (below 26.67), medium (26.7 - 97) and high (above 97) by applying descriptive statistics. Vikramgad and Wada has less % percentage of complaint solved. Vikramgad has the highest number of ST population in the district. Vasai, Jawahar, and Talasari has high value for complaint redressal. The remaining Taluka has average performance.

4.4.3 Presence of Staffs Available

There are two major mechanisms to control the malfunctions of TPDS in Palghar district. One is village participatory vigilance committee and other is inspection by Supply Inspection officer. Different levels of employees need to inspect certain targets every month and need to report the higher officials. The number of available employees is a key element in the efficient monitoring and reporting of the TPDS. The district officials provided the information about total staffs who required to do the monitoring and maintenance.

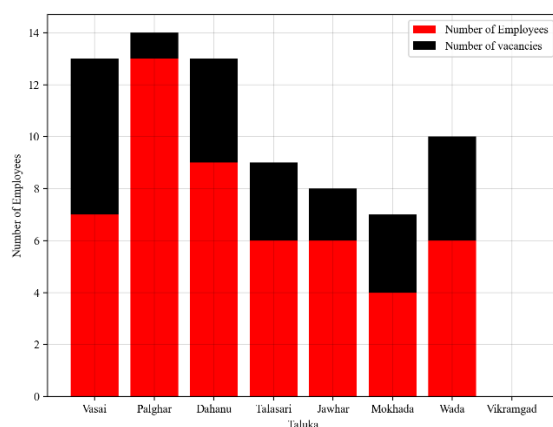


Figure 4.30 Number of Employees

Figure 4.30 shows the number of employees available and number of vacancies. There are no officials/employees available at Vikramgad. The staffs from neighbouring Taluka used to inspect the FPSs of Vikramgad Taluka. Other than Palghar, all the Talukas have significant vacant posts of employees are available, which reduce the efficiency of monitoring and evaluation of TPDS system at the district. Total sanctioned posts, available staff and vacancy are given in Table 4.7.

Table 4.7 Staff Details

Taluka	Total sectioned posts	Available Staffs	Vacancy
Vasai	13	7	6
Palghar	14	13	1
Dahanu	13	9	4
Talasari	9	6	3
Jawhar	8	6	2
Mokhada	7	4	3
Wada	10	6	4
Vikramgad	0	0	0

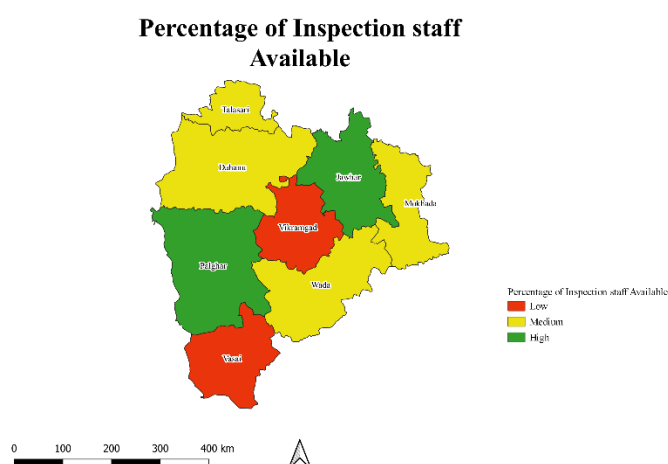


Figure 4.31 Percentage of staff available

Figure 4.31 is showing the percentage of staff available at each Taluka. Vikramgad and Vasai have low value (0-56%). Palghar and Jawahar have more than 70.5% employees to monitor the TPDS of respective Talukas. The staffs from Palghar, Wada, Jawahar and Dahanu are also look into the Vikramgad Taluka. District officials mentioned that they were started procedures to increase the staffs in order to increase the performance of the system.

4.5 Conclusion

For evaluating the TPDS, four major dimensions are considered, and 12 indicators are identified. The data collected from different sources such as government IMS, portals, documents and from district officials for each Taluka. The different indicators and their values in Taluka wise are provided in below Table 4.8.

Table 4.8 Indicators and its values

Taluka	Ratio of allocation	Ratio of distribution	Public distribution Ratio	Storage Ratio	Road Density	Population density per FPSs	% GIS enabled FPSs	% of EPOS availability	Online Payment facility	Data availability on portal	% of complaint resolved	% of staff available
Dahanu	0.98	0.79	94.31	7246.38	32.08	1.82	46.86	92.27	0.00	1.00	85.00	69.23
Jawhar	0.95	0.91	256.42	8854.17	45.99	2.18	97.92	94.79	0.00	1.00	100.00	75.00
Mokhada	1.06	0.83	4277.34	11718.75	37.13	2.47	1.56	95.31	0.00	1.00	75.00	57.14
Palghar	0.94	0.78	125.31	7990.87	19.40	2.33	33.33	97.72	0.00	1.00	78.46	92.86
Talasari	1.05	0.90	1450.12	10869.57	53.20	7.76	0.00	94.20	0.00	1.00	100.00	66.67
Vasai	1.03	0.72	367.10	11111.11	250.52	12.73	43.89	100.00	0.00	1.00	96.04	53.85
Vikramgad	0.93	0.87	385.09	3804.35	48.80	2.76	17.39	89.13	0.00	1.00	26.67	0.00
Wada	0.93	0.81	180.81	9554.14	44.67	1.38	45.22	78.34	0.00	1.00	48.00	60.00

Chapter 5

Composite Index for Evaluating TPDS

Measuring any micro-macro level valuation of social, economic, and political elements with a single indicator is very hard. Increasing heterogeneity and complexity of real-world phenomena required combination of specialized indicators and these indicators might fall into different dimensions or pillars(Booyesen, 2002).

For the evaluation of TPDS at a district level, this study focuses on four major dimensions or pillars such as food distribution, infrastructure, technology and monitoring. This chapter explains ow the composite index formed and how the indicator can be used to evaluate the performance of TPDS in Palghar district, Maharashtra. The parameters are selected from literature in such a way that the composite index can be used in universally – for any location at any level.

A composite index is prepared by combining different indicators together. It is a mathematical function from R_n to R . The aim of the composite index is to reflect overall status of the phenomenon from a set of indicators. Human Development Index, Hunger Index etc are some popular composite indices used in social sciences (Chakrabartty, 2017). CI can summarize multidimensional realitiex to a single view which is helpful for policymakers and normal people to interpret the situation (European Commission. Joint Research Centre. & Organisation for Economic Co-operation and Development., 2008). The CI can be used a tool to compare the realities of different places. Meanwhile poorly constructed CI will land to inappropriate policies.

Construction of composite index has different steps. They are

5.1.1 Selection of Indicators

Selection of indicators is the first step for making CI, and is depend upon the purpose, relevance and availability of the data. The selection of indicator or variable based on a theoretical framework and the indicators should have analytical soundness, relevance and measurability.

5.1.2 Data Collection

Valid data should be collected from different trusted places like scholarly articles, government notifications and government IMSs. Each data need to analyse in terms of phenomena going to address. Proxy variables can be used if the actual data is not available.

5.1.3 Normalisation of Data

Normalisation of data is required to change the original distribution and make the indicators free from unit. While doing the normalisation, the range of the indicators will scale and it can be easy for making assumptions and interpretations. Ranking, Standardisation (Z score), Min Max normalisation, Categorical scale are some example of normalisation method used to make a CI.

5.1.4 Aggregation

The normalised values are aggregated by mathematical formula to converge into a single value. Weighted aggregation is the most common method available. Selection of weightage is the central activity, and hence the selection of weightage should be careful. The selection of weightage can be done by normative, or data-driven and hybrid methods.

5.2 Preparation of TPDS Index

For analysing the performance of TPDS, 12 parameters under four dimensions are selected. The dimensions are food distribution, infrastructure, technology and monitoring. Ratio of distribution, ratio of allocation and PDR are selected under food distribution, Storage facility, road network, population density per FPS are chosen to study infrastructure. % of GIS enabled FPSs, EPoS machine availability and online payment facilities considered for technology. Monitoring Pillar consists of data availability on portal, % of complaint resolved and number of staff available. Number of staff available is a proxy variable to measure the performance of grievance redressal.

Data is collected from different resources and analysed with the help of GIS tools for understanding the spatial variation of each variable. Min-max normalisation method is used to

normalise the values. For that, subtract the minimum value and divided by the range of values for each indicator. Considering the equal importance of each variable, equal weightage is given to all indicators.

To analyse the correlation between each variable, Karl Pearson's coefficient of correlation method is used and the correlation heatmap is generated. The following is the formula for Pearson's coefficient.

$$\text{Karl Pearson's coefficient} = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{\Sigma(x-\bar{x})^2 \Sigma(y-\bar{y})^2}}$$

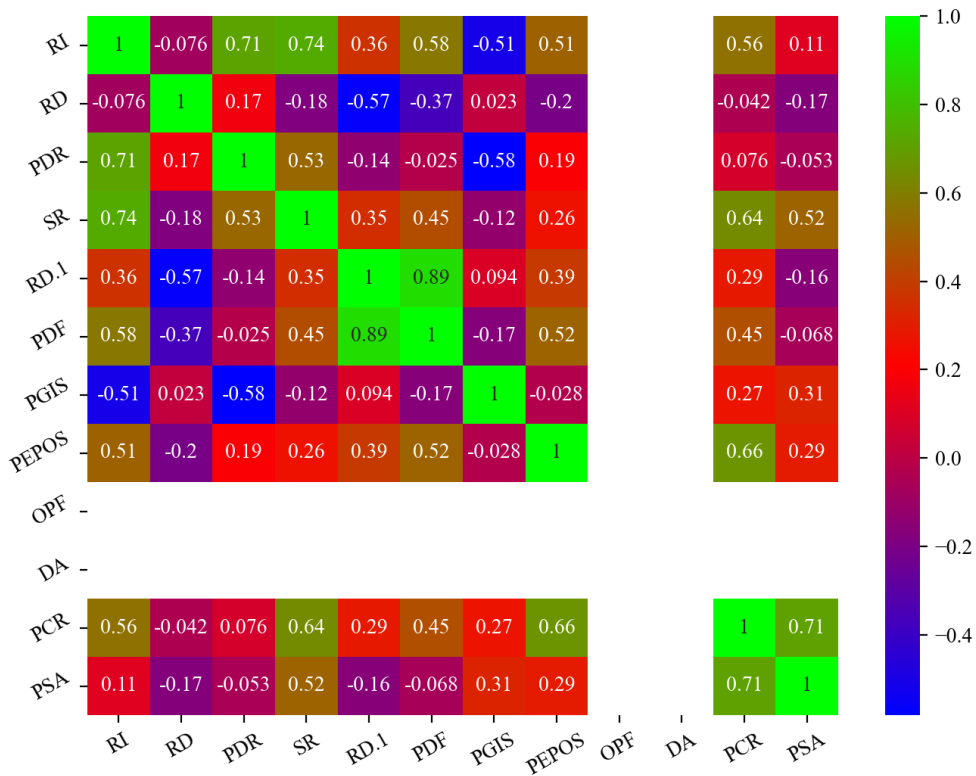


Figure 5.1 Heat map of correlation of variables

Figure 5.1 shows the heatmap of correlation of 12 variables. The value zero means there is no correlation between the variables and are having random relationship between them. One means the correlation is positive. The negative numbers showing the negative correlation between the variables. Due to the shortage of space, short forms are used to represent the variables as mentioned in Table 5.1.

Table 5.1 Variables and short forms

Sr No	Variable Name	Short form
1	Ratio of allocation	RA
2	Ratio of distribution	RD
3	Public distribution Ratio	PDR
4	Storage Ratio	SR
5	Road Density	RD.1
6	Population density per FPSs	PDF
7	% GIS enabled FPSs	PGIS
8	% of EPOS availability	PEPOS
9	Online Payment facility	OPF
10	Data availability on portal	DA
11	% of complaint resolved	PCR
12	% of staff available	PSA

Since the value of online payment facility (OPF) and Data availability on portal (DA) not varying, there is no valid correlation coefficient and its shown as white space in the Figure 5.1. A

Z score normalisation is performed to scale the available data. The following equation is used to find normalise the data.

$$Z = \frac{x_i - \mu}{\sigma}$$

PDR value is adjusted by taking the complement, since it has an inverse proportion with the performance of TPDS. The normalised values are show in Table 5.2. This table provide an idea about how far each value is distributed far from the middle tendency.

Table 5.2 Normalised values

Taluka	RI	RD	PDR	SR	RD.1	PDF	PGIS	PEPOS	OPF	DA	PCR	PSA
Dahanu	0.27	-0.46	1.15	-0.76	-0.18	-0.15	0.26	-0.33	NA	NA	0.12	0.22

Jawhar	-0.27	1.39	1.04	-0.14	0.01	-0.06	1.88	0.04	NA	NA	0.69	0.43
Mokhada	1.73	0.15	-1.76	0.97	-0.11	0.02	-1.18	0.12	NA	NA	-0.26	-0.23
Palghar	-0.45	-0.62	1.13	-0.47	-0.35	-0.02	-0.17	0.48	NA	NA	-0.12	1.1
Talasari	1.54	1.23	0.21	0.64	0.1	1.34	-1.23	-0.04	NA	NA	0.69	0.12
Vasai	1.18	-1.54	0.96	0.74	2.73	2.59	0.17	0.83	NA	NA	0.54	-0.35
Vikramgad	-0.64	0.77	0.95	-2.09	0.05	0.09	-0.67	-0.8	NA	NA	-2.09	-2.35
Wada	-0.64	-0.15	1.09	0.14	-0.01	-0.26	0.21	-2.42	NA	NA	-1.28	-0.12

Based on the values, $I_{Food\ Distribution}$, $I_{Infrastructure}$, $I_{Technology}$, and $I_{Monitoring}$ found out by applying geometric mean. Geometric mean provides a central tendency and calculated by multiplying all number in the series and find the n^{th} root of the product. Table 5.3 provide the indices obtained for each pillars. Vasai is performing the best in food distribution and infrastructures dimensions whereas Wada performing the worst in food distribution and infrastructure.

Table 5.3 Table of Indices of Pillars

Taluka	$I_{Food\ Distribution}$	$I_{Infrastructure}$	$I_{Technology}$	$I_{Monitoring}$
Dahanu	4.179622	75.07159	65.7554	76.71082
Jawhar	6.052094	96.1072	96.34229	86.60254
Mokhada	15.55438	102.4317	12.19359	65.46373
Palghar	4.512349	71.21704	57.0702	85.35687
Talasari	11.10739	164.941	3.069202	81.6517
Vasai	6.481139	328.4552	66.24953	71.91491
Vikramgad	6.779351	80.02084	39.36967	1.633095
Wada	5.145135	83.82281	59.5192	53.66563

Jawahar performing the best in technology and monitoring direction of TPDS. In food distribution dimension, Mokhada got the highest score and Dahanu got the lowest score. Infrastructure level, Vasai perform the best and Palghar the least. Talasari and Vikramgad fall behind the list in technology and monitoring respectively.

Table 5.4 denote the TPDS index calculated by geometric mean of the four indices. Vikarmgad got the lowest score, and Vasai got the highest score.

Table 5.4 TPDS Index

Dahanu	Jawhar	Mokhada	Palghar	Talasari	Vasai	Vikramgad	Wada
35.4691	46.93559	33.58187	35.37192	26.03052	56.43289	13.66599	34.25927

5.3 Ranking of Talukas based on TPDS Index

Based on the TPDS Index, ranking of each taluka is calculated and plotted in the graph. As mentioned earlier, Vasai got rank 1 and Vikramgad got rank 8. Jawahar, and Dahanu got second and third rank. Talasari and Mokhada got 7th and 6th rank respectively. Even though Vasai got first rank, the performance in food distribution and monitoring facilities are not so good at Vasai Taluka. Similarly, the food distribution in Vikramgad ranked three, better than top ranked Vasai, Jawahar and Dahanu. Food distribution of Palghar and Dahanu are ranked 7 and 8.

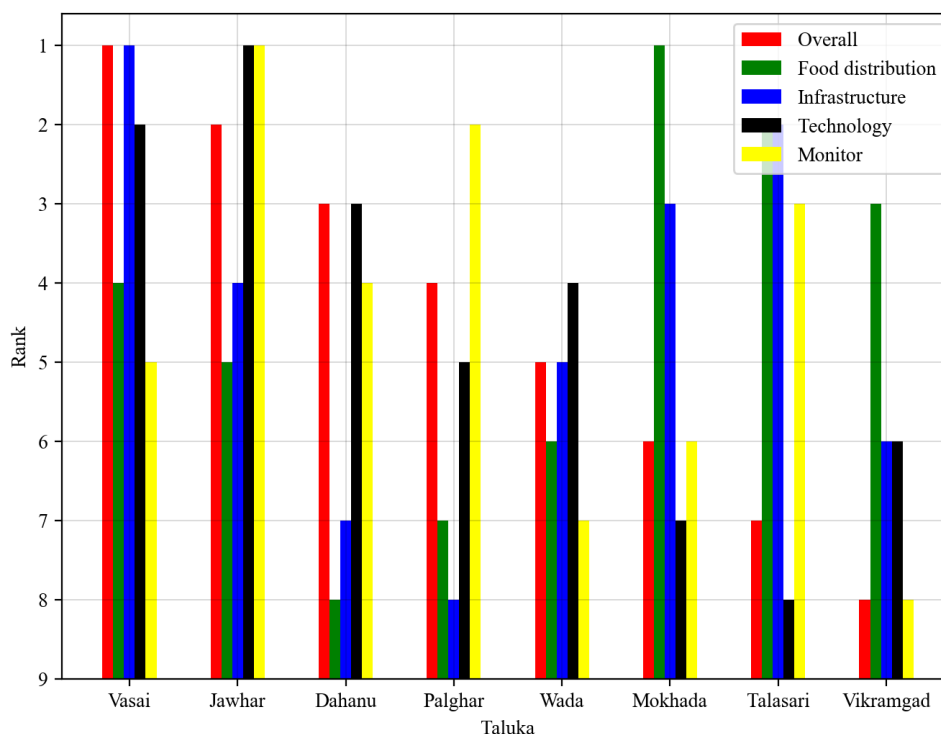


Figure 5.2 Ranking of Palghar district

Figure 5.2 shows the overall ranking and ranking in each individual dimensions considered for the study.

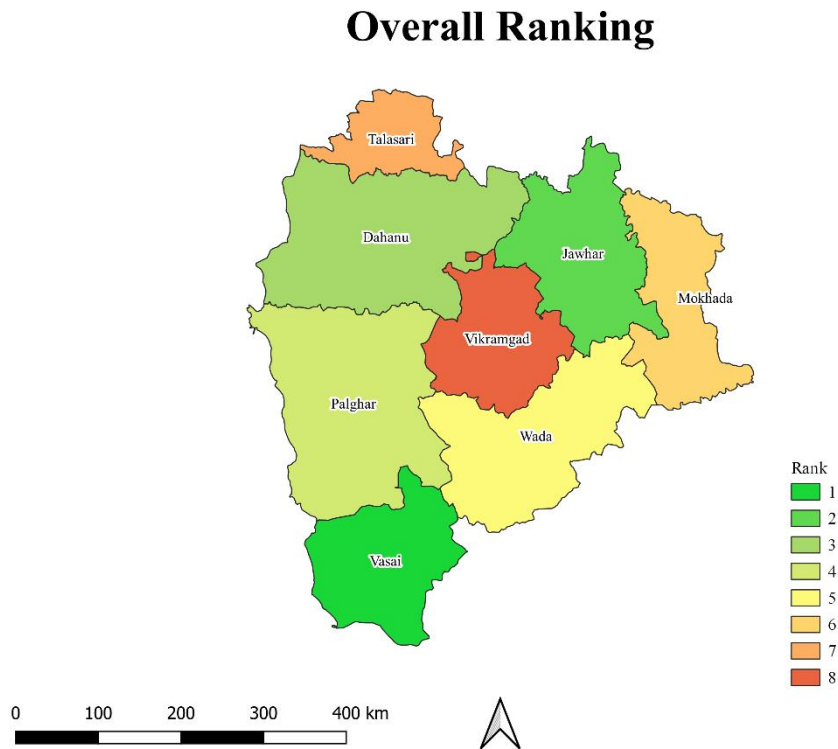


Figure 5.3 Overall Ranking

Figure 5.3 shows the spatial diagram of ranking. Vasai got first rank which is more urbanised, and near to the Mumbai city. Whereas the faraway Talukas such as Vikramgad, Wada, Talasari and Mokhada are not performing well in ranking.

Chapter 6

Conclusions

The major objectives of the study were evaluation of TPDS of Palghar district with GIS tools and construct a composite Index based on different variables. Literature review has been done related to the evaluation of TPDS, geo spatial evaluation of public projects, evaluation of food distribution system done in India as well outside India etc. The data is collected from various sources such as government orders, research articles and Government IMSs. Most of the data collected from Maharashtra state TPDS portal(<http://mahaepos.gov.in/#>) and Central NFSA portal (https://nfsa.gov.in/portal/PDS_page) and Annavitran portal (<https://annavitran.nic.in/>). Many data related to distribution, complaint redressal, and EPoS data provided by District Supply Officer, Palghar district. Latest geo related data and shapefile downloaded from trusted sources. Road length, total area of the Taluka etc. extracted from geospatial data. To analyse and make visualisation, MS Excel, QGIS, Pandas, Matplotlib etc are used.

Composite index is used to analyse the complicated social phenomena. Global Hunger Index, Global Hunan Index, Hunger Index, SDG goal ranking, etc are some of the examples where composite index method is used and helped to understand the scenario with a numeric value. For this study, four dimensions are used to evaluate the performance of TPDS. Each dimension and its parameters are determined by literature review. For making the index, different approach is learned and utilized the best suitable – Weighted aggregation method. Since selected variables have equal important the weight used is one.

Food distribution is the first dimension considered for the study. Under this dimension Public Distribution Ratio (PDR), Ratio of allocation and Ratio of Distribution considered. Ratio of allocation is equal or greater than one, but the distribution ratio is less than one. That showing some leakage in the distribution side of foodgrains. PDR shows whether the number of FPSs is enough for the beneficiaries. After ranking, Mokhada achieved rank 1 and Dahanu got rank 8. Talasari and Vikramgad are other performers in food distribution Index.

For analysing the infrastructure of TPDS, storage facilities, road density and population density per FPS are used. There are 23 godowns for 8 Talukas having a total capacity of 9495 MT. Mokhada has least storage ratio while Vasai has the highest storage

ratio. For Vikramgad, the storage facility is least, but due to the smaller number of beneficiaries, the value of storage density is comparatively good. For Palghar, 3310.32 KM of various roads are available and total road density is 59.83. Palghar Taluka has least road density (19.40 KM/100SqKM). Vasai has the highest road density due to the urbanisation. In average, there are four people are served by an FPS in 1KM for Palghar. Vasai has the highest score for population density per FPS. In overall, Vasai scored rank 1 for Infrastructure Index.

To analyse technology, three parameters are used, % GIS enabled FPSs, % of EPOS availability and Online Payment facility. The district official claimed that there is no FPS using online payment facility. So, the value of the indicator considered as zero and avoided from actual calculation of Technology Index. Talasari Taluka not yet started the mapping of FPSs and Jawahar is achieved near to 100%. The district supply office is trying to implement EPoS in every FPSs, but due to the technical issues, installation of EPoS does not happen for 77 FPSs. Apart from Wada and Vikramgad, all Taluka achieved more than 90% installation of EPoS machine. Jawahar ranked 1 in technology index and Dahanu ranked 8. %GIS mapping score of Dahanu drag the ranking in technology Index.

Data availability on portal, % of complaint resolved and % of staff available is considered for making the Monitoring Index. The district official claimed that the data availability on portal is done by every Taluka properly. The data from portal proved the statement by districts officials. Staff available is considered as a proxy variable since every employee has to go field and monitor the working of FPSs and update the values in the portals regularly. The lack of employees will directly affect the monitoring of TPDS. From data of last two years, Jawahar and Talasari resolved 100% complaints since they are getting only few complaints per year. Where Vasai and Palghar are getting a greater number of complaints and resolved more than 75% of the complaints. There are no staffs available for Vikramgad Taluka. Vasai has highest number of sanctioned posts, but only 50% is available. Jawahar got rank 1 and Vikramgad got rank 8 for Monitoring index.

For overall performance Vasai got rank 1 and Vikramgad got rank 8. The Table 6.1 provide an overall insight on ranking of different Talukas.

Table 6.1 Ranking of Talukas

Taluka	Food distribution Index	Infrastructure Index	Technology Index	Monitoring Index	Overall
Vasai	4	1	2	5	1

Jawhar	5	4	1	1	2
Dahanu	8	7	3	4	3
Palghar	7	8	5	2	4
Wada	6	5	4	7	5
Mokhada	1	3	7	6	6
Talasari	2	2	8	3	7
Vikramgad	3	6	6	8	8

6.1 Limitation

The study did not mention various factors directly related to the performance of TPDS like food consumption pattern change with respect to time, financial viability of FPSs, financial benefits of different beneficiaries, area based variation of financial benefits, quality of foodgrains delivered, availability of alternative sources of foodgrains, social and economic access to the FPSs etc. The performance of TPDS during the COVID time is another important factor, which is not included in this study.

In order to analyse the TPDS in detailed way required more time and resources. To make the Indexing accurate, intensive field visit and primary data collection is required. Due to the third wave of COVID pandemic, and limitation of time, beneficiary interview was not included in the study. Some of the analysis done in this research is based on the 2011 census data which is more than 10 years old and affect the quality of the conclusions.

6.2 Future work

In future, the research elaborates by collecting more primary data and modifying the ranking methodology and selection of the variables and dimensions. Currently the ranking is done at a single district level. In future, trying to apply the same ranking index in various levels from village to state. Also planning to make a mathematical prediction model so that the Government, policymakers, researchers can optimise the TPDS efficiency with available conditions. A geospatial analysis a portal with various types of visualisations need to develop so that different stakeholders of TPDS like Government, NGOs, policymakers, can understand the scenario easily and can focus on less performing area/sector.

Appendix

Appendix I: Field visit report: Two FPSs at Powai, Mumbai

Understanding the working of TPDS in Mumbai

In order to understand the working of TPDS at the ground level, field study at local FPS is required. The first field visit was completed on 27 Nov 2021, from 4:00 pm to 7:00 pm at Powai, near the Market gate of IIT Bombay. The field visit to one FPS would not give the exact picture of what is happening in reality. So, to get more information, I visited another FPS near Powai English Medium School. With the help of Google map and a couple of inquiries with local people helped to reach the destinations by bicycle. The major purpose is to contact some of the beneficiaries and the storekeeper of FPS to get some basic introduction and understand the reality. Language is the biggest barrier faced during the entire field visit.

The main purpose of the visit is to understand the exact working of TPDS, how they distribute the food grains to beneficiaries, what are the records they used to keep at shops, the operation timing of FPS, how they get the stocks, what are the items serving in FPS, what is the size of FPS, What are the equipment they are using for service, whether there any items other than TPDS items for selling, how many people utilising the TPDS etc.

First shop

The first shop is at Hanuman Road, near the Market gate of IIT Bombay. The FPS is situated in the road side, so that the beneficiaries and distributor can easily access the store. The registration number of the shop is U-MOM 30 E132. The working hour of shop is from 8:00 am to 1:00 pm and 5:00 pm to 8:00 pm. The shop opened at sharp 5:00 pm. The shop is operated by two labors, one is sitting at the counter and other distribute the food grains. They said that the owner of the FPS rarely come to the shop. The beneficiaries started coming at 5:00 pm itself and made a queue for purchasing their food grains(4 people). The shop is in a tiny room and having some extension to back side for storing more sacks of food grains. Both the labors did not have much idea about how much stock available, how much money the shop owner get for distributing food grains, the rent of the shops etc. The stocks are coming from Panvel and Borivali. The labor who sit at the cash section didn't disclosed such details. "We are working for the owner, he knows everything. We don't need to know any thing, we got a salary for doing our job, There is no record here" – by the cashier. The FPS is selling

Wheat, Rice and kerosine. Apart from PDS item, different non PDS items like sugar, salt, Dals, mirchi, and stationary items etc are also sold by the shop. There are more than 1000 families are registered under the shop. There is no record other than an E-Pos machine. The beneficiaries are authenticated by biometric pin. The details are collected and stored the central portal. The cashier collects the money and acknowledge by signing in the Ration Cards of beneficiaries. There is a QR code pasted so that the beneficiaries can use online and mobile payment also. The labour told that people were using mobile phone to pay the bills. He also said that most of the people were collect their food grains properly.

Below are some pictures of shop 1



Second Shop

The second shop situated near the English medium high school, Nana Palshikar Marg, Powai and numbered as U-MUM-30-E108. Since the time is near 5:30 pm, there was many people (nearly 25) reached to collect their benefits. People are coming continuously. Most of the people coming by their own scooter or a hired autorickshaw. The store is small and there

was two persons working – one was proceeding the biometric procedure, collecting money and signing on Ration cards, the other is weighing and distributing food grains. The shop is not selling any non PDS items.

From the interactions between different type of beneficiaries give more information from their point of view. According to them, they would get good quality food grains in cheap rate from FPS. Most of the families purchasing it and it helped them. In this shop, people get more quantity of Wheat rather than Rice. Three people claimed that they get 3 Kg of Wheat per person and 2 Kg of Rice per person for a month. They said that it is not enough, but it was helping to reduce their monthly expenditure for food grains. 90% of the people holding Orange Ration card which is for priority household category. Only 10% hold red card for AAY. There is no person with Non priority cards. The ration cards seem very old. One person told me that if they missed the food gains of one month, it would not get on another month. The person who is in the cashier claimed that they didn't get any extra stock. The balance stock automatically recorded on the central portal, based on that the food grains distributed to FPS from AFSSO. After acknowledging, he turned to his work.

Some of the images from Second shops are given below.



Conclusion

The field visit helped to understand the basic working, pattern of FPS, how many people are using the facility (rough estimation), the importance of PDS in life of common people etc. It was very difficult to get the accurate data because there was no registers need to keep in FPS. Triangulating the rough data given by the labors from the FPS can not be possible since the reference number in the ration shop and the website is entirely different.

From the website of FCI, it is found that godowns are available at Borivali and Panvel, which was mentioned by the cashier of shop 1.

Language is a big barrier for field visits and more preparation required to cover more points while doing the field visit. These visits helped to understand the precautions and preparation required for a field study.

Appendix II : Semi structured interview guide - beneficiaries

Face-sheet

1	Respondent No/Name				
2	Participant Category	<input type="checkbox"/> AAY <input type="checkbox"/> PHH <input type="checkbox"/> APL <input type="checkbox"/> None			
3	Age				
4	Gender	<input type="checkbox"/> Male <input type="checkbox"/> Female <input type="checkbox"/> Others			
5	Place (City/Village)				
6	Nearest FPS				
7	Taluka		District		
8	Household Size	Male		Female	
		Child	Adult	Child	Adult
	Land Ownership	<input type="checkbox"/> Landless <input type="checkbox"/> Land areaUnits.....			

9		
10	House Ownership	<input type="checkbox"/> Own House <input type="checkbox"/> Rental house
11	Main Employment	<input type="checkbox"/> Farmer <input type="checkbox"/> Daily Wage Earner <input type="checkbox"/> Seasonal or Long-Term Migrant Worker <input type="checkbox"/> Local Private Employment <input type="checkbox"/> Industrial Employment <input type="checkbox"/> Other
12	Education	<input type="checkbox"/> Pre-SSC (... Std.) <input type="checkbox"/> SSC <input type="checkbox"/> HSC <input type="checkbox"/> Bachelors
13	Social Category	<input type="checkbox"/> SC <input type="checkbox"/> ST <input type="checkbox"/> OBC <input type="checkbox"/> Others
14	More information (if required)	
15	Date	
16	Time started	<div>Time ended</div>

I. Accessibility

1. How much distance from your home to your FPS?
2. Is there any other FPS nearer to your home?
3. How much time you need to travel to reach FPS?
4. How difficult to collect foods from FPS in different seasons?

5. Are you facing any issues to collect food from FPS (due to less stock, technical issues etc.)?
6. What is the mode of transporting you are using to collect food grains from FPS?
7. How frequent you will get a particular mode of transport facilities(Auto, bus etc.)
8. How frequently you visit FPS?
9. Is there any thing that you would like to be in a different way?
10. Could you able to purchase the food grains every month from the FPS?
11. Financial accessibility
12. Do you have/your family have job?
13. Do you get enough money to buy food grains from FPS?
14. Will FPS provide food items in credit system?
15. Who is normally going to collect the food grains from FPS?
16. Is there any reason to send her/him for collecting the food grains?
17. Are there any other stores those more beneficial than FPS?

II. Availability

1. Is the food available through out the year/ across all seasons?
2. Whether the food from FPS is enough for your entire family?
3. If no, how do you manage the food for entire family?
4. Do you like the choices available in the FPS?
5. Do your family members like the choices available in the FPS?
6. What are the other food items you wished to include in FPS?
7. What are the other food sources available other than FPS?
8. What are the other sources of food source which is sustainable across the seasons?
9. What will you do if you get some extra food?
10. Do you think lack of infrastructure affect the availability of food in your place (compared to city)

III. Utilisation

1. What are the major food items you are eating more often?
2. What are the major ingredients you are using for cooking food?
3. Are you getting enough water to cook the food?
4. What is the major source of water?
5. How far it is from your home?
6. What is the cooking fuel using for preparation of food?

7. What is the availability of cooking fuel?
8. What are the other difficulties you facing while cooking?
9. How do you use the food grains from the FPS?
10. Do you think the FPS food items are helpful? And how?
11. What is the major source of income which is used to purchase food?
12. Who is making the income for purchasing food?
13. Who is handling food cooking in your home?
14. What is your strategy to avoid food insecurity in your house?
15. In your home anyone have/had diseases like anemia, nutrition deficiency diseases?
16. In your home, anyone have cholesterol, diabetes?
17. Any of your children facing issues of malnutrition?
18. Do you have toilets in your home?
19. Do you get any other benefits from Government for buying food or food items(like ICDP, Pregnant women, mid day meal etc)

Appendix III: Semi structured interview guide – District Supply Officer, Palghar

- What are the challenges at TPDS at various levels?
- What are the initiatives taken by the district administration to reduce the issues at Taluka /district level?
- How many employees working under the TPDS system?
- Any other collaboration with other departments/organisations to improve the performance of TPDS
- Are there any region wise issues in the operations of TPDS?
- How is the complaint mechanism in TPDS is working?
- Whether the vigilance committee is available at Taluka level, if yes please provide the information including who is the head, who are the members of the committee etc.
- What are the challenges in GIS mapping of FPS in some Talukas? Could you please provide the data?
- What are the other benefits for PHH and AAY cardholders? Anything specifically for each group?
- Any study is going on to evaluate the TPDS by district administration?
- How much money each FPS owner will get?
- How many applications per year for new FPSs?
- How does the transaction of money happen?
- How many FPSs are allowed to sell non PDS items to increase the economic viability?
- Locations of storages at each Taluka? And Service area of each storage area?
- How the taluka level storage works? Like where do they get the food grains, how much time they can store the food grains, facilities at the local storage facility etc.
- What are the data sources public ally available so that I can get?

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