

STUDY DIFFERENT INVENTORY MANAGEMENT MODULES IN DVDMS AND EVALUATE THEIR EFFECTIVENESS IN MANAGEMENT OF STOCK

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By

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Under the Supervision and Guidance of

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Dated: 02nd July 2024

To

Mr. Anubhav Barik

Intern- Quality and Patient Safety (Drug Cell)

NHSRC, New Delhi

Dear Mr. Anubhav Barik ,

This refers to your Summer Internship from 29th April 2024 to 28th June 2024 in National Health Systems Resource Centre (NHSRC).

You are relieved from the post of Intern- Quality and Patient Safety (Drug Cell) w.e.f 28th June 2024 (A/N), on completion of your internship. We would like to thank you and wish all success in your future endeavors.

Brig. Sanjay Baweja
Principal Administrative Officer

DECLARATION BY STUDENT

I, Anubhav Barik hereby declare that this dissertation titled **Study different inventory management modules in DVDMS and evaluate their effectiveness in management of stock**, is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Anubhav Barik

(Signature)

Anubhav Barik

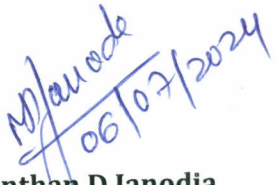
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CERTIFICATE

This is to certify that dissertation titled **Study different inventory management modules in DVDMS and evaluate their effectiveness in management of stock** is a record of the research work undertaken by Anubhav Barik in partial fulfillment of the requirements for the award of the degree of MBA (Pharmaceutical Management from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.



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Abstract

In the competitive environment of companies today, where efficiency tops the list of ceasing to be an added advantage, optimum inventory management is one of the strong corners of business success. This paper primarily dwelling on the different modules of inventory management as embedded in the said framework. It is in this work, specifically, that the complex workings of the Drug & Vaccine Distribution Management System are explored. It is, therefore, this study that vehemently makes an effort to evaluate thoroughly the efficacy of each module in effecting proper stock control. This multidimensional approach to empirical investigation further advances to go on and make a systematic dissection of strengths and weaknesses of various inventory management modules within DVDMS in the present research endeavor. In detail, this provides insight into their actual effects on KPIs: stock optimization, cost reduction, and operational efficiency in general. Quantitative metrics shall be viewed with a keen eye in comparison with qualitative assessments to illustrate a full landscape of complex dynamics that govern inventory management in the digital age. This multifaceted evaluation framework will provide invaluable insights for companies that are marinated in the intricacies of modern supply chain management. This dissertation ultimately provides practitioners with a compass toward making informed decisions and facilitating innovative strategies concerning streamlined stock control in the context of a more ubiquitous DVDMS ecosystem.

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1 Introduction

1.1 History

Prior to the establishment of massive pharmaceutical corporations, neighborhood apothecaries frequently manufactured medications. The core goals of inventory management were to maintain a minimal supply of raw materials and completed goods and to focus on basic record-keeping. Early inventory control was mostly done by hand, using ledgers to keep track of records. (1) The post-war period saw the introduction of early computer systems. This era marked the beginning of automated inventory management. (2)

1.2 Background of the study

DVDMS is an online electronic supply chain management system prepared to cover the procurement, inventory management, and distribution of drugs, sutures, and other surgical items by various health facilities or government health facilities and drug distribution counters at state or UT level. DVDMS will also help in ensuring the Free Drug Service Scheme at health facilities through an improved supply chain of drugs, sutures, and surgical items. For effective monitoring of FDSI, MoHFW, in fact, has also initiated a dashboard by harnessing on suitable aggregation tools, triangulation systems, and business intelligence tool for conceptualizing an actionable system with a provision of real time analytics. The advanced analytical tools capture Key Performance Indicators related to stock out %, consumption pattern, demand & supply trend, storage and procurement, quality control, logistics, etc. DVDMS has been implemented in 21 States in the Union of India. Ensuring that an extensive heterogeneous populous has equal access to essential drugs and vaccines, which are usually widely of need, usually presents a big challenge to the healthcare landscape of India, and mostly to any huge metropolitan state. This calls for an effective and robust drug distribution system. The Drugs and Vaccine Distribution Management System is a software solution package that is designed to help automate the numerous activities at the DGMH. That's more than ordinary inventory management; it looks into the overall drug and vaccine supply chain, right up to the purchase orders and, eventually, distributions at the local level. The new landscape in distribution is of a dynamic nature and very competitive. Within that environment, the efficient management of inventory has crossed the rubicon from an additional advantage to outright necessity for business success. Distributors always face the tightrope walk between maintaining sufficient inventory levels to satisfy customer demand and minimizing the crippling costs of overstocking. Stock outs mean no sale at all, a base of frustrated customers, and loss of one's reputation. On the other hand, too much inventory ties up expensive capital, inflates storage costs, and places products at risk of obsolescence. Inventory control was based on manual methods and experience-based intuition. Things have since changed drastically. With the increasing complexity of supply chains, erratic fluctuations in demand patterns, and an explosion in product variety, more sophisticated solutions are needed. It is in this context that the Drugs & Vaccines Distribution management system, DVDMS, will revolutionize the way distributors manage their stock. DVDMS represent a paradigm shift in inventory management. They are powerful systems with a set of integrated modules. specifically designed to automate previously manual processes, leverage the power of data analytics for informed decision-making, and provide distributors with real-time Armed with this kind of real-time visibility, the distributors are fully armed through the DVDMS

where they can proactively make the necessary changes in order to allow just-in-time inventory, minimizing overstock and under-stock, and maximizing efficiency. This research will conduct an in-depth analysis into the versatile modules that are incorporated into the DVDMS to manage inventory. It will manage to break the operation of each module and further manage an analysis, for logic of operation, on maximizing stock efficiencies for the distributor. We will close our exploration with a highly forceful evaluation of the effects on the KPIs: profitability, customer satisfaction, and operational efficiency. This dissertation aims to further this dynamic line of inventory management research in the changing world of distribution with a multi-dimensional methodology, including a thorough literature review, case studies, and widespread data analysis. Our results will thus be expected to offer significant pointers to stakeholders and contributors in ways that will enable them to negotiate modern complexities associated with the inventory and the development of innovative strategies regarding stock control within the relatively ubiquitous DVDMS ecosystem. The major challenges for DVDMS as accurate and updated data across the multiple stakeholders across are so crucial. Data inconsistency only creates inventory management problems is only a failure case for the entire systems. Drug and vaccine coding system Data interchange and reporting within the DVDMS across different healthcare facilities and geographical locations are quite challenging as different drug and vaccine coding system. Other than that, the DVDMS also depends on the availability of good internet connectivity in the healthcare facilities, which might not be possible even in most remote areas. Further, the support hardware and software compatibility in varied systems can be complicated.

1.3 Objectives

The aim of the study is to critically review some of the embedded inventory management modules in the DVDMS, giving an overview of the efficacy of such modules in managing stocks within health facilities. The study identifies and describes each of them, stating the specific functions and responsibilities of the module. The study will attempt to explore, in detail, the functioning of all these modules, understood both in isolation from and conjunction with each other in working toward the common goals of keeping stock levels accurate, ensuring timely replenishments, and reducing the number of stock outs as well as waste. Additionally, the dissertation shall seek to evaluate the operational efficiency realized from each module. This is done by measuring it against impact on select performance indicators, which include the accuracy of stock, the frequency and timeliness of restocking activities, and the incidence of inventory imbalances such as shortages or excess stock. In an effort to assess these measures, this paper makes an attempt to uncover how effectively these modules cull down inventory processes and so. The performance metrics should be looked for, together with these inventory management modules. This would involve researching user experiences with inventory management modules and establishing how healthcare professionals and system users apply them to practice, common challenges and limitations they might experience in using the modules, and general satisfaction with the system. Such an understanding would prove very instrumental in elements that may make the DVDMS need improvement or even optimization to make it more user-friendly and effective. In a nutshell, the result of such evaluations would be synthesized to give action-oriented recommendations towards optimizing the inventory management capabilities of the DVDMS. This will include the proposing of best practice suggestions within which to use these modules in realizing higher efficiency, reliability, and responsiveness in managing pharmaceutical and vaccine stocks. This research will provide valuable information about inventory management strengths and the potential for improvement, in guiding healthcare facilities toward more effective and efficient inventory management practices that promote improved patient care and operational excellence.

1.4 Justification

In India, the vast geographical areas and large populations make ensuring equal access to essential drugs and vaccines a difficult problem. DVDMS holds great promise as an automated mechanism in drug distribution, with its full impact on inventory management practices yet to be realized. Still, there is a need for insight into how the DVDMS impacts inventory management practices. It is a tough job to maintain the availability of essential drugs and vaccines in the right quantity at the proper time at all the geographically distributed dramatically large areas and among different populations. The availability of Drugs and Vaccine Distribution Management System (DVDMS) to some extent cures this situation by an automation approach; it covers the overall supply chain of drug distribution. More needs to be known about how DVDMS works in practice in relation to inventory management, however, so that its potential is maximized. It seeks to fill this gap in knowledge through an investigation of the effects of the inventory modules in DVDMS and analysis of the related effectiveness in optimization of stock control for the healthcare distributor. We will evaluate the extent of effect that DVDMS has on organizational performance dimensions such as profitability, customer satisfaction, and operational efficiency. Therefore, the aim of our study is to draft a framework that can assist both practitioners and academicians in developing better inventory control within the framework of the DVDMS system, and help in the streamlining of innovative strategies for better-implemented controls in stock toward a more efficient and effective working DVDMS. Finally, it contributes to the dream of better access to essential medicines for patients all over India. This study developed further optimization strategies by examining the critical issues and challenges in DVDMS implementation related to data accuracy, standardized coding, reliable internet connectivity in remote areas, and robust data security, thus making the dissertation worth evaluation and recommendation for policymakers, healthcare administrators, and IT professionals working for the functionality and efficiency of the DVDMS system.

1.5 Scope

This dissertation will cover a general review of the inventory management modules' effectiveness in managing the stock in healthcare settings by the Drug and Vaccine Distribution Management System (DVDMS). In this research, attention will be pinned on the key modules that enable inventory control, and a detailed analysis will be conducted in terms of monitoring stock levels, managing reordering and replenishment processes, distribution and allocation management, expiry, waste management, and reporting and analytics-related functionalities. The function of each module will be carefully analyzed for design, functionality, and how it integrates into the larger framework of DVDMS. The performance of these modules on key performance indicators relevant to good inventory management practice will be a very salient part of the assessment. These indicators would relate to the accuracy and reliability of information about stock levels, the effectiveness, and responsiveness of the mining process as well as the ability of the modules to ensure that minimum stock-outs and overstock situations occur. It will further evaluate gained operational efficiencies from the use of the modules in terms of workflow, costing of savings, and utilization of facilities at any given healthcare facility. The study will be conducted in different health care operations within which DVDMS can be implemented, including hospitals, clinics, and other health care providers. A range of contexts in operation—geographical and organizational type—are analyzed here, so the expected broad lot of challenges and practices can be captured. This variation would avail an in-depth knowledge of how each of the inventory management modules would perform under varying conditions and requirements. Another very important part of the study will be the investigation of the actual experiences of the system users. Actual research will be conducted soliciting feedback on the use of each module, along with questionnaires and

interviewing where pharmacists, inventory managers, and other health professionals will be involved in the study. The study will identify common challenges and limitations that users face, assess overall satisfaction, and evaluate whether these modules impact their day-to-day inventory management tasks. The comparative analyze will be done by the dissertation towards a holistic view of the performance and user experiences across the different inventory management modules. This analysis will seek to show the strengths and weaknesses of each module, while pinpointing best practices and successful features within the DVDMS framework. Based on these findings, the research will provide actionable recommendations that can see the system optimized in such a way that its inventory capacity can be fully enhanced to enable this provision in a much more efficient and effective manner. This study, however, recognises that attention is going to be called on inventory management of DVDMS and not any other functionality unless if it has a direct bearing or effect in the inventory process, for instance; financial management and tracking of data about patients. While user input is central to the study, attention to broader organizational or issue/policy level will be considered to the extent that it bears a direct relationship to inventory management within the DVDMS. In maintaining this focus, the dissertation strives to achieve a detailed and targeted evaluation that can inform improvements in healthcare supply chain efficiency and reliability.

2 Literature Review

Comprehensive Evaluation of Inventory Management Modules in the DVDMS Central Dashboard: Assessing Effectiveness, Challenges, and Pathways for Improvement

Introduction

Vaccines and Drugs Distribution Management Information System represents an important subsystem to ensure proper and effective distribution and management of essential drugs and vaccines in the context of the public health infrastructure in India. With both the burdens of diseases and an evolving demographic profile, the effective inventory management of the DVDMS Central Dashboard becomes a main line of supply to sustain continuous drug availability and minimize any stock-out situations. This literature review looks at the general issues around the current inventory control measures of DVDMS and ways through which such measures can be effective in inventory stock control.

Overview of DVDMS and Inventory Management

The DVDMS was implemented in the continuum of India's endeavor to rationalize the procurement, distribution, and tracking of drugs and vaccines. The DVDMS system embraces several Inventory Management modules, which will seriously consider making the supply chain more effective and ensuring health commodities are available at the last mile in a time-bound manner. Some of the main components that lie within the inventory management module are as follows:

Centralized Procurement and Distribution: In this module, drugs and vaccines are centrally purchased in bulk and distributed to main, state, and regional warehouses.

Inventory tracking and monitoring: Provides real-time information about stock levels and makes replenishment possible in a timely manner, thus considerably reducing the likelihood of running out of stock.

Demand forecasting and planning: would use historical data and predictive analytics to arrive at an estimate for future demand and plan procurements based on these estimates.

Stock visibility and traceability: The IT-enabled system allows the visibility of stock levels and status in distribution at various points across the supply chain to the stakeholders.

Challenges in Inventory Management

Despite the potential benefits of the DVDMS, several challenges persist in effectively managing inventory:

Inefficiencies in procurement and supply chain: While centralized procurement may attempt to achieve economies of scale and homogeneity in drug availability, there are frequently stumbling blocks such as delayed supplies, bureaucratic hurdles, and variability in local demand. Sometimes, the centralization process cannot hold the specific needs of different regions, leading to mismatches in supply and demand. The management systems may, therefore, create a source of mismatch between supply and demand (Bigdeli et al., 2015).

Bullwhip Effect and Stock Variability

It is susceptible to the bullwhip effect, in which small changes in demand can result in increasing variability in the inventory levels up the supply chain. This can further be intensified by poor, lumpy forecasting of the demand, and purchasing contracts that are quite rigid, resulting in overstocking or stock-outs (Van Olmen et al., 2010).

Localized Procurement Challenges

To support these centralized efforts, while some states have developed their own drug procurement corporations there is large variance in the maturity and effectiveness of these entities. Quite common inadequacies include poor adherence to procurement processes, restricted use of analytics for demand forecast, and suboptimal practices in managing stock (National Health Systems Resource Centre, 2021).

Effectiveness of DVDMS Inventory Modules

Centralized Procurement and Distribution

Overall coordination and bulk purchasing ability is improved by this centralized procurement module in DVDMS, being very effective in cost reduction and increased efficiency at supply chains. However, many times this efficiency is hindered by logistic delays and an inability to respond promptly to the local fluctuations in demand. A great number of studies find that in countries like India, this can be achieved through flexibility in procurement contracts and decentralized decision process at the local level (Bhargava & Kalantri, 2013).

Inventory Tracking and Monitoring.

It has hugely enhanced the visibility of the stock levels and the distribution flows through real-time inventory tracking and monitoring. This module detects any possible shortages and enables ONLY replenishment on time. IT-enabled transparency through DVDMS will help maintain a consistent level of stock at different healthcare facilities (Institute for Health Metrics and Evaluation, n.d.).

Demand Forecasting and Planning

The demand forecasting and planning module requires historical data to predict future requirements. This model is quite successful through advanced planning with the challenges faced in successfully forecasting demand, especially in remote rural areas where consumption patterns may be erratic. Advanced analytics and machine learning algorithms are the areas being explored in order to fine-tune demand estimation and improve forecasting accuracy (Tripathy et al., 2016).

Stock Visibility and Transparency

A stock visibility module allows visibility of the status of inventory at all levels of the supply chain, thereby promoting accountability and reducing pilferage. The system empowers healthcare providers and administrators to make informed decisions regarding stock management. However, its full potential is sometimes underutilized \because of inadequacy in training and resistance to technology adoption, among some stakeholders (Wang et al., 2015).

Recommendations for Improvement

To further enhance the effectiveness of inventory management within the DVDMS Central Dashboard, several recommendations can be considered:

Enhance Forecast Techniques: Utilize advanced analytics using machine learning models to help make demand forecasts precise and adjust to real patterns of consumption.

Flexible Procurement Strategies: Adopting more flexible procurement contracts that would quickly adapt to changes in demand and supply conditions can reduce the impact of the bullwhip effect.

Capacity Building and Training: Developing the capacities of stakeholders at all levels to utilize the DVDMS modules for effective decision-making, based on information data.

Allow more decentralization at the state and local government levels with respect to decision-making processes concerning procurement and distribution, in relation to respective needs and challenges.

Conclusion

The 'DVDMS' central dashboard is, hence, the substratum for managing drug and vaccine inventory across India's public health system. This, though having introduced many improvements in supply chain efficiency and stock management, there are still many outstanding issues. Advanced forecasting and procurement flexibility, coupled with better trainings, will give effective inventory management that will ensure that there should not be any break in the availability of drugs to enable universal access to healthcare.

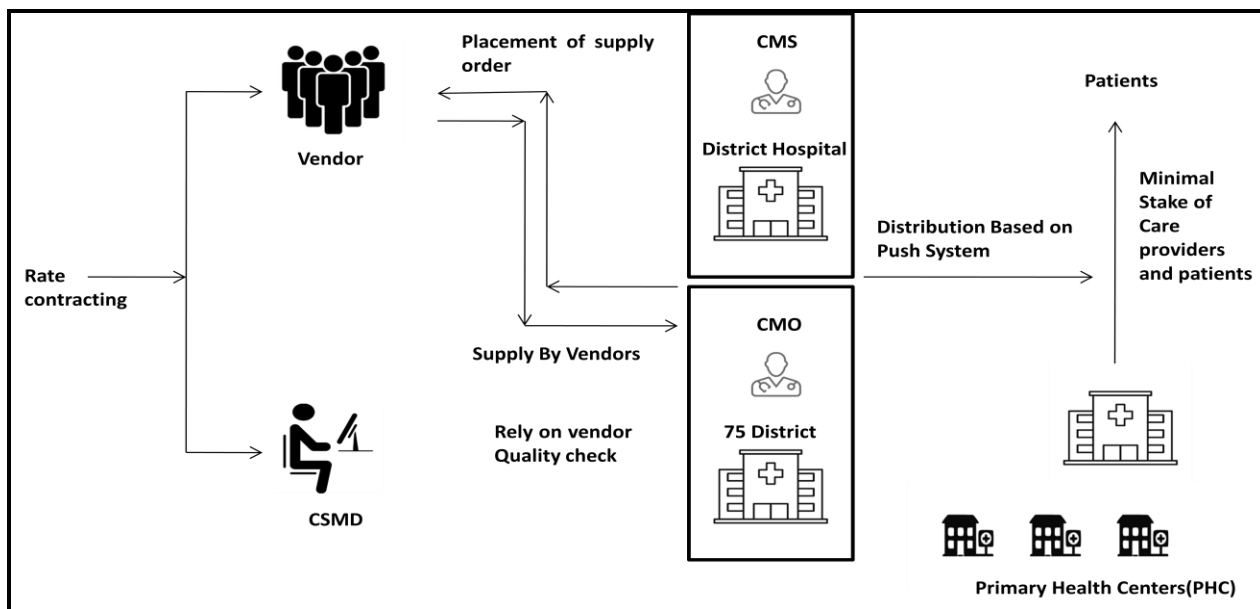
Restructured Public Health Drug Distribution System in Uttar Pradesh (UP)

Introduction

A healthy healthcare system ensures the availability of essential drugs, vaccination, and medical supplies. This indirectly affects the general trust of the public in the system and the health outcomes of patients. Public hospitals play a very vital role in helping consumers pay less out-of-pocket. It is valid in the case of India, where the private sector controls between 60 and 70 percent of healthcare. However, the sufficient supplies of such medicines in public health centers are always difficult to maintain. This review discusses the restructuring in the public health drug distribution system of Uttar Pradesh, with a view on the innovative approach of UPMSC in increasing the accessibility of drugs through the Drugs and Vaccine Distribution Management System.

Drawbacks of the conventional method

The result of the situation was a conventional public health drug supply system rife with shortages and inefficiency, internal to the Ring Road-in UP's government department. As per the Comptroller and Auditor General of India, the system was incapable of meeting the needs of physicians and patients properly; it did suffer from frequent stock-outs and pushed patients to the more expensive options in the private sector. This consequently caused more financial distress to the patients, and also dented their trust in the public healthcare system (IHAT, 2020). The conventional drug distribution model in UP had many bureaucratic layers, which made decision-making slow and unresponsive to actual need at the facility level — see Fig. 1.1. These inefficiencies had therefore to be reassessed and drug supply chain reordered so that at least the drugs would be delivered on time.



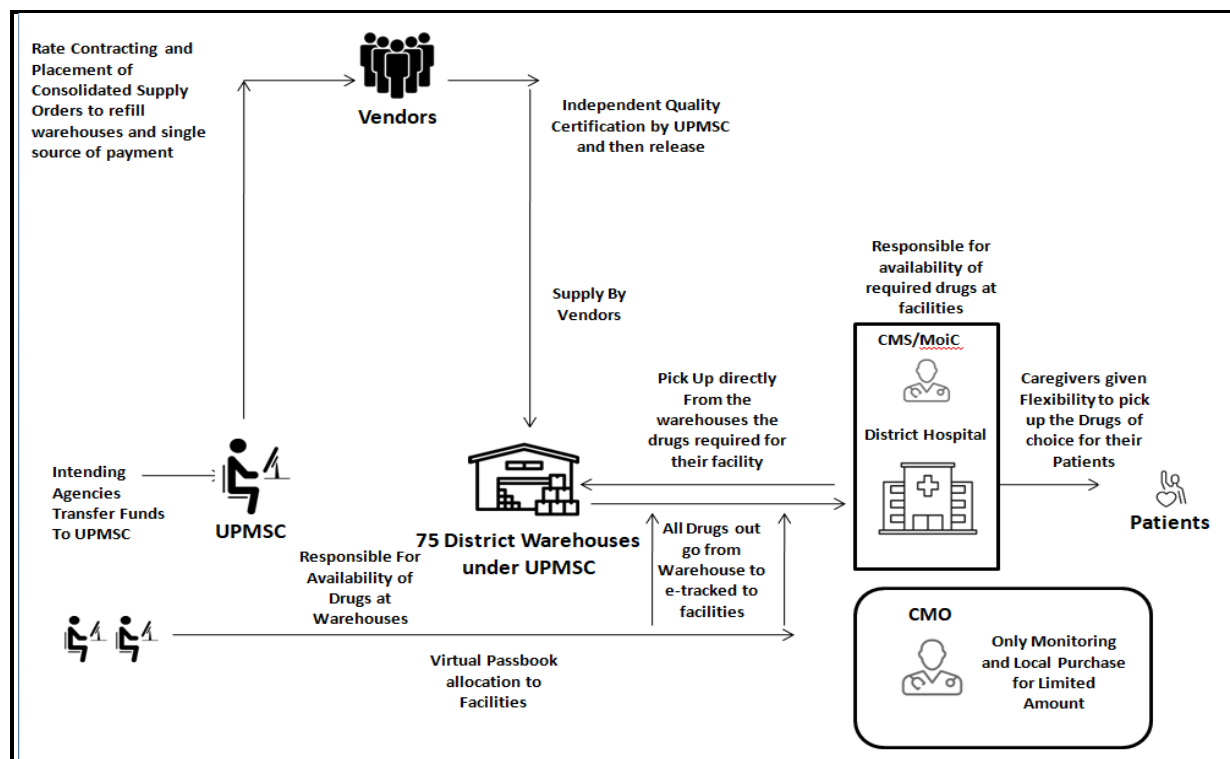
Source: System Design Support to Deliver Quality Drugs at Public Health Facilities in Uttar Pradesh [Internet]. India Health Action Trust (IHAT).

(Fig. 1.1)

The Uttar Pradesh Medical Supplies Corporation (UPMSC) Model

The Uttar Pradesh Medical Supplies Corporation was initiated by the UP government in collaboration with the Uttar Pradesh Technical Support Unit, recognizing the need to help solve such challenges. It sought to integrate procurement and supply of drugs and medical commodities. The model was benchmarked against successful public health supply chains already in action in other states of India. Creation and Organization of UPMSC Originally conceived to be an independent entity, UPMSC was conceived for the purpose of procuring, warehousing, and distributing medications and medical supplies to public health facilities in the state. The firm has a flat organizational structure with few levels of management, a robust utilization of digital tools in order to maximize efficiency, and transparency in operations. There is DVDMS —a drug and vaccine distribution management system—in the new system, enhancing inventory management and tracking within the supply chain in real-time.

(Fig. 1.2)



Source: System Design Support to Deliver Quality Drugs at Public Health Facilities in Uttar Pradesh [Internet]. India Health Action Trust (IHAT).

Key Components of UPMSC's Supply Chain Model

The six primary pillars of success for UPMSC all center on making the supply chain more effective and agile:

1) EDL: The Essential Drug List is the unread list of around 300 vital pharmaceuticals selected in trends of diseases and demographic requirements in the United Provinces. Such a focused list will ensure that resources are fed into only the most essential pharmaceuticals, thereby maximizing the utilization of budgets and reducing wastes. (IHAT, 2020).

2) District Level Warehouses: For maintaining the medicines in the most ideal conditions, UPMSC had established district-level, well-equipped warehouses. These would carry unprecedented levels of stock to secure an uninterrupted supply of essential pharmaceuticals to reduce the risk of stock outs at the local level. (IHAT, 2020).

3) Centralized Procurement: The centralizing of the procedure will allow UPMSC to take benefit of economies of scale and save a lot of money. Procurement decisions are taken based on an in-depth study of data regarding Co routine historical consumption trends and

present disease patterns to arrive at a correct estimate of demand and have a uniform supply of Medicine throughout the state. (IHAT, 2020).

4) Passbook System: Each hospital is given a passbook containing an allocated budget for prescribed drugs. This budget will include many drugs that each individual hospital is unlikely to use or purchase, allowing the hospitals to strike out, from the overall budget, drugs they would never use, avoiding overstocking, and using the money effectively to pay for other prescriptions that are warranted. (IHAT, 2020).

5) Quality Control: To be sure of safe and effective medicines, rigorous quality control processes must be implemented. Every batch going out to the warehouses is tested by independent laboratories in a blind, double-blind method to ensure unbiased tests. Only pharmaceuticals that pass these vigorous tests make it to the hospitals, thus assuring equity in quality of health care. (IHAT, 2020).

6) Centralized Payments: One-stop shop for on-time payments to vendors, UPMSC reduces delays and encourages the participation of bigger pharmaceutical corporations in the procurement process. This kind of strategy helps in negotiating better prices and quality for needed drugs. (IHAT, 2020).

Impact and Evaluation of UPMSC

There has been tremendous improvement in the general availability of pharmaceuticals and the efficiency of the supply chain because of the restructuring process of UP's public health drug distribution system by UPMSC. The UPMSC introduced a responsive and more transparent system that is adept at meeting the demands of PH facilities through its six pillars. Of all, DVDMS provided real-time data that optimized inventory management and decision-making, hence the most significant influence. The model that UPMSC provided is one of how SCMS strategies can be employed to enhance overall healthcare delivery, reduce wastage, and ensure the accessibility of essential pharmaceuticals. This reduces the financial burden on patients, thereby enhancing public trust in the health system.

Conclusion

The formation of UPMSC and implementation of DVDMS are the two major steps toward reassurance about the availability of essential pharmaceuticals in the reorganization of the public health drug distribution system in Uttar Pradesh. It ensures strict quality control over medicines, improves inventory management, and streamlines procurement procedures—all of which were missing inadequacies in the traditional system. The successes that UPMSC achieves serve as important lessons to be drawn on how other regions may improve their public health supply chains to ensure quality healthcare at an affordable cost.

3 Research Methodologies

3.1 Research Design

This goes further to allow an elaborate comprehension of the system's functionalities, user experiences and operational effectiveness. The study is structured into several phases:

- **Literature Review:** The literature review offers an in-depth review of inventory and management systems, focusing, in this case, on DVDMS, for further development of a theoretical framework and identification of research gaps.
- **Case Studies:** Detailed case studies of selected healthcare facilities on how DVDMS can be used and for further insight on its application and impact in reality.
- **Data Analysis:** This activity includes statistical and thematic values from the collected data, which will be used to measure effectiveness in the inventory management modules of DVDMS and draw cues for other areas of augmentation.

3.2 Data Collection Methods

To gather comprehensive data, the following methods were employed:

Literature Review: This has involved a systematic review of relevant academic journals, government reports, and industry publications to trace the evolution, functionalities, and challenges of inventory management systems in healthcare, particularly DVDMS. This review provides foundational understanding and helps to inform the design of subsequent data collection instruments.

Case Studies: Direct observations, document analysis (inventory logs, procurement records), and informal discussions with staff to gather the context of how DVDMS were implemented and are being operated.

3.4 Limitations of the Study

Data Access and Availability: Access to data was, in some cases, very limited for sensitive or proprietary data, limiting the analysis scope.

Generalizability: The study's results may be specific to the Indian context and DVDMS only; they have to be adapted to other regions and systems after some refinement is made within that context.

3.5 Summary

This chapter included a description of the study methods used to assess the DVDMS's inventory management capabilities. The study intends to give a thorough examination of DVDMS performance, user experiences, and opportunities for development by utilizing a mixed-methods approach. The study aims and the topic of healthcare supply chain management are supported by the methodology, which guarantees a strong and moral framework for data collection and analysis.

4 Discussions

To evaluate the performance of the inventory management modules in the DVDMS Central Dashboard, successes and those places that need more tuning were highlighted. This paper is focused on the primary elements of system performance, the challenges the system faces, and ways of improvement open to public health supply chains.

Effectiveness of DVDMS Inventory Management Modules

Centralized Procurement and Distribution:

Centralizing the procurement and distribution approach in DVDMS has created large improvements in coordination, bringing cost efficiency across India's vast public health landscape. The unit costs are lowered through bulk purchases made by the system and result in considerable savings towards more reliable availability in essential drugs and vaccines. This model, however, at times lacks logic, especially when there are delays, indicating that there is a need for a more dynamic system that will respond in time to the regional and local changes of demand. Therefore, flexible procurement strategies and decisions at the local level could thus offer some kind of buffer against these challenges and provide a more resilient supply chain that can react to changing needs.

Inventory Tracing and Monitoring:

Such intermittent monitoring of stock levels relates highly to maintaining optimal stock levels and reducing cases of stock-outs within this DVDMS. This transparency in inventory flow will help in timely replenishment, which is the very thing that adds to the least shortages at health facilities. The improvement in this area will be clearly shown by visibility and accountability through the supply chain. However, actual realization of these benefits comes from robustness in the underlying IT infrastructure and efficiency in the users of the systems. This, therefore, calls for continuous investment in technology upgrading and training programs in order to keep reaping and extrapolating the benefits recounted.

Demand forecasting and plan:

Procurement for DVDMS is based on demand forecasting and planning that use past data to project future supply needs, and provides a proactive planning base. Many times it has to face a big challenge because of varying unpredictable consumption patterns in diverse and far-off areas. With infusions of advanced analytics and machine learning, there will be apparent improvement in the precision of forecasting and hence, the agility in responding to fluctuation. The introduction of these technologies will require a sustained commitment to data quality and constant refinement of predictive models.

Stock Visibility and Traceability:

The module ensures accountability in the supply chain, where stakeholders have an eye on the inventory status from the central warehouses down to the local health facilities. Equally, it is a tool in minimizing losses due to pilferage and ensuring that the drugs and vaccines reach their required destination. However, sometimes it does not achieve its full potential due to insufficient training and resistance to adopting new technologies exhibited by some users. Bridging these barriers through focused training and developing a culture for accepting technological change are the ways to go for optimal utility of this module.

Challenges in Inventory Management**Procurement and supply chain inefficiencies**

Even though centralized procurement has a number of advantages, the bureaucratic hurdles and logistical challenges that are inherently part of it will eventually lead to inefficiencies. Inefficient processes lead to mismatches between supply and demand, where the supply at the local level does not align with local needs. The rigidity of this system often lacks flexibility in adjusting quickly to those variations, so a more nuanced approach is likely needed in order to balance these concerns between central control and local flexibility.

Bullwhip Effect and Variability in Stock

One big challenge to the efficiency of DVDMS is the bullwhip effect, whereby even insignificant changes in demand by the consumer result in exaggerated stock variations higher up of supply chain. This may result to over-stocks or stock-out situations that a system should never allow for. Mitigating this effect should involve refined techniques to forecast demand and more adaptive procurement practices that might iron out these variations.

Localized Procurement Challenges:

The regional drug procurement units, therefore, vary in maturity and performance level, with a couple of them being unable to follow properly established best practice in the areas of procurement and storekeeping. In most instances, this generally can create serious inconsistencies from one region to the other in drug supply and quality. The improvement in the capacity of these local units through training and support is therefore paramount to ensure some level of uniformity in the procurement process that will yield maximum effectiveness.

Recommendations for Improvement**Improving Forecasting Techniques:**

Advanced analytics and machine learning models have to be built into DVDMS to enhance forecasting accuracy. Such analysis can try to factor in the sophisticated consumption patterns and all the external circumstances to produce more reliable forecasts, enabling the system to adjust closer to actual demand. These enhancements will require investment in data analytics capabilities and continuous refinement of forecasting algorithms.

Flexible Procurement Strategies:

This will greatly help to minimize the impact of the bullwhip effect through the incorporation of procurement strategies that are flexible and responsive to variations in demand triggers and supply source conditions. The flexibility could involve dynamic procurement contracts, decentralized decision-making, and adaptive logistics plan scalability based on needs in real time.

Capacity building and training opportunities:

For all these stakeholders to be conversant with, and make better use of, the DVDMS, their capacities, from central level administrators to local health facility managers, have to be built accordingly. This implies the development of a sound training program so that users at different levels can operate all the modules of the system competently. In this respect, regular refresher courses and support in case of troubleshooting will be done so that a high degree of competence and commitment is sustained.

Decentralization in Decision-Making:

Increased decentralization at the local level in regard to procurement and distribution decisions can lead to increased responsiveness to need. The requirement for state and local entities to make informed decisions about context-specific needs and challenges can be clearly mandated as a means for driving improvement in the overall efficiency and effectiveness of the supply chain. This devolution must, however, be underpinned by clear guidelines and oversight mechanisms seeking to ensure accountability and consistency with broader strategic goals.

Broader Implications for Public Health Supply Chain Management.

The evaluation of the DVDMS modules also provides relevant lessons for the broader public health supply chain management context. The crux of effective inventory management goes beyond stock availability to putting in place a resilient system where management can respond with agility to changing conditions and diverse needs. The lessons learned from DVDMS can inform similar systems in other regions or countries, particularly in how an appropriate balance is achieved between centralization and local flexibility, how technology is leveraged for real-time visibility, and maturation takes place through advanced analytics and stakeholder engagement.

5 Results & Findings.

The in-depth review of modules for inventory management across the DVDMS Central Dashboard turns out to be a mixed story of successes and issues that would need to be improved. This section outlines the performance of the system against key metrics and outcomes for core functionalities such as centralized procurement and distribution, inventory tracking and monitoring, demand forecasting and planning, and stock visibility and traceability. It also shows the impact of these modules on healthcare delivery and how stakeholders of this public health infrastructure get engaged with these modules.

Centralized Procurement and Distribution

Challenges Identified:

Logistical Delays:

While there has been a gain in efficiency overall, there have been periodic logistical challenges regarding transport delays and red tape value chains that interfered with timely deliveries, more so in the rural and remote areas. This has become a great worry in the not-so-well-maintained infrastructure states.

Top-Down Approach:

This has resulted in isolated mistakes wherein it failed to adapt itself to regional demand; hence, overstocking or running short in supply occurs. These mismatches are put on the rigidity of central procurement processes that never really take into account regional demand variations.

Inventory Tracking and Monitoring

Challenges Identified:

IT dependency:

The tracking of inventory depends much on how efficient the IT infrastructure may be, and this has proved a challenge in areas where connectivity is not up to the required standards. This has led to delays in stock replenishment, with facilities in these regions facing challenges in accessing real-time data.

User Experience:

Differences in user competencies resulted in less uniform data entry conventions and use. This had the effect, in some cases, of creating inconsistencies between actual and reported stock levels.

Demand Forecasting and Planning

Challenges Identified:

Variability in Consumption Patterns:

In highly variable or unpredictable consumption patterns for that matter, the forecasting model has turned out to be a model that predicts demand in wrongly forecasted areas, most specifically in the rural and underserved areas, which resulted in either shortages or excess stock in those regions.

Data Quality and Completeness:

In some instances, the process has been compromised by historical data that is incomplete or inaccurate, undercutting the credibility of the forecasts and the necessity to institute stricter practices in the maintenance and collection of data.

Summary:

The DVDMS Central Dashboard has significantly improved cost-efficient inventory management with real-time visibility and proactive stock replenishment in place. All these have borne greatly on the availability of essential drugs and vaccines, more so in well-connected and technologically supported regions. As such, meeting up with all such logistical delays by oneself—the constant supply-demand mismatch, IT infrastructure dependencies, and user proficiencies—has led to the planned efficiency of the system not coming into place in many areas. Moreover, variability in consumption patterns and data quality should be taken into consideration to become an obstacle in effective demand forecasting. General Impact: The system has made remarkable strides in improving public health supply chain across the expanse of India; but there is a very real imperative to address the problems identified along the way to more consistent and equitably powerful results across the diversity of healthcare found in India. Current findings reveal procedures for improving forecasting techniques, increasing flexibility in procurement strategies, enhancing capacity building, and decentralizing decisions further.

6 Conclusion

This evaluation of DVDMS Central Dashboard and the UPMSC model adequately describes the critically important role played by adequate inventory management for the availability of essential drugs and vaccines within the Indian Public Health System. Although both the systems brought in significant improvement with respect to supply chain effectiveness, visibility, and accountability there are challenges that still remain. To unleash the full potential of these systems, there is a need for adaptation of more flexible procurement strategies, better demand forecasting techniques, greater investments in IT infrastructure and user training, and promotion of a culture of continuous improvement. Further investment and fortification of the public health supply chain in India create the last mile assurance for access to essential health care commodities for all. Universal health coverage is the ultimate goal in this respect. More specifically, the UPMSC model is a best practice that other regions could learn from in order to build up their public health supply chain. It is the shining star guiding the additional development of procurement processes, inventory management, and the guarantee of drug safety, which it pursues to get health care with a high degree of quality and at a lower cost. The further streamlining and best practices in the public health distribution setup, up to the challenge of concerns identified by the study, have the key in attaining better health outcome for the population within India.

7 About DVDMS

7.1 Introduction

Imagine a high-tech command center, buzzing with activity. On large screens, maps of different states of India, flicker with real-time data. This isn't a scene from a sci-fi movie; it's the DVDMS central dashboard, the brain behind the Drugs and Vaccine Distribution Management System. While not accessible to the public, for authorized users, it's a game-changer in managing the state's medication supply. Think of the dashboard as a giant control panel for the flow of essential drugs. It provides government officials and staff working on the DVDMS with a real-time window into every aspect of the drug supply chain. It tracks everything from purchase orders to the current stock situation in different warehouses located across the state. This is not all concerning stock control. Acting like a crystal ball, this dashboard uses past data and trends to project the quantum of medicine each region will require at different times of the year. This facilitates advance planning and allocation of resources so that no hospital is hit by a critical shortage. But that is not all. Visualize the dashboard as a virtual bazaar. It takes prices from drug suppliers across India, guaranteeing the government the best available deals. This is a significant cost-saving that can now be used to buy many more life-saving medicines. Probably the most critical function is being able to point to possible bottlenecks. It shows, in real-time, the passage of medications through the supply chain—with delays or inefficiencies highlighted. This enables the authorized user to act quick enough and removes all the bumps that might block the drugs' way from the warehouses all the way to hospitals and clinics. In brief, the DVDMS Central Dashboard is a powerful tool for informed decision-making. It's a vast amount of information that authorized users have to go through and analyze in order to proactively solve the potential shortages, optimally allocate the resources, and ensure that India's people get the medications they need, when they need them.

7.2 Advantage of DVDMS system

- The top-down approach facilitates future better monitoring and control at head office.
- Support improved administration-wide planning and execution.
- Effective inventory and supply management.
- Full Package with optimal capabilities for a centralized supply chain management system.
- Optimal performance when there are plenty of users.
- Capable of expanding functionality in accordance with departmental preferences and available infrastructure.
- Monitoring and controlling the quality of drugs as well as quality control over them.
- DDC's online medication distribution to patients.
- Integration of intra-depot excess/short medication transfer with headquarters.

- Payment to Supplier Dependent on Performance.
- The User Help & Solution Desk.

7.3 Key Features

- The option to sign a rate agreement with suppliers.
- Use a centralized database server to store, manage, update, search, and display drug-related information across several retailers.
- Forecasting and demand generation are simple.
- Online indenting on a yearly demand basis or based on a need-based request for purchase from DDWH to Head Quarter.
- The creation of purchase orders at headquarters based on unified indenting.
- The District Level Consolidated Indenting is used to generate Purchase Orders.
- The creation of purchase orders online for vendors.
- Simplicity of Challan entry at DDWH in comparison to the issued Purchase Order.
- Online drug distribution depending on drug availability and purchase.
- The ability to preserve an item's shelf life or expiration date when appropriate.
- Drug Quality Control.
- The ability to track the drug inventory online in all state institutions.
- Support improved demand and supply planning, execution, and control.
- The ability to create personalized reports.
- Different color-coded alert creation facilities, such as those for quarantine, reorder level, and expired items.
- The ability to find medications in all institutions using a variety of search parameters.
- A clause requiring all drug warehouses to be connected hierarchically in order to comprehend both their functional and physical structures.
- Inter-DDWH Drug Transfer under appropriate HQ supervision.
- Bar Code Interface for a product's distinct identification. (5)

7.4 Major KPI

- State Wise Demand Data.
- State Wise Consumption Pattern.
- State Wise Stock Availability.
- State Wise Drug Expiry.
- State Wise Stock-outs.
- State Wise Supply / Receipts.
- State Wise Logistics.
- Program Wise Demand Data.
- Program Wise Consumption Pattern.
- Program Wise Stock Availability.

- Program Wise Drug Expiry.
- Program Wise Stock-outs.
- Program Wise Supply / Receipts.
- Program Wise Logistics.

7.5 Availability of automated v/s manual LMIS across States / UTs, 2018-19.

STATE	State Warehouse	Regional Warehouse	District Warehouse	Block Warehouse
Andhra Pradesh	Manual	NA	Manual	Manual
Arunachal Pradesh	Automated	NA	Manual	Manual
Assam	Automated	NA	Automated	Manual
Bihar	Automated	Automated	Automated	Manual
Chhattisgarh	Automated	NA	Automated	Automated
Delhi	Manual	NA	Manual	Manual
Goa	Automated	NA	Automated	Manual
Gujarat	Automated	Automated	Automated	Manual
Haryana	Automated	Automated	Automated	Automated
Himachal Pradesh	NA	NA	Manual	Manual
Jharkhand	Manual	Manual	Manual	Manual
Karnataka	Automated	NA	Automated	Automated
Kerala	Automated	NA	Automated	Automated
Madhya Pradesh	Automated	NA	Automated	Automated
Maharashtra	Automated	Automated	Automated	Automated
Manipur	Automated	NA	Automated	Manual
Meghalaya	Manual	NA	Manual	Manual
Mizoram	Manual	NA	Manual	Manual
Nagaland	Manual	NA	Manual	Manual
Odisha	Automated	NA	Automated	Automated
Punjab	Automated	Automated	Automated	Manual
Rajasthan	Automated	NA	Automated	Automated
Sikkim	Manual	NA	Manual	Manual
Tamil Nadu	Automated	NA	Automated	Automated
Telangana	Automated	Automated	Automated	Automated
Tripura	Automated	NA	Automated	Manual
Uttar Pradesh	Automated	NA	Automated	Manual
Uttarakhand	Manual	Manual	Manual	Manual
West Bengal	Automated	Automated	Automated	Manual

Source: (4)

7.6 Frequency of Stock MIS updation at various levels by States / UTs, 2018-19

State	State Level	Regional Level	District Level	Block Level	Sub centre Level	School Level	Anganwadi Level
Andhra Pradesh	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Arunachal Pradesh	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Assam	Real-time	NA	Real-time	Weekly	Monthly	Monthly	Monthly
Bihar	Real-time	Real-time	Monthly	Monthly	Monthly	Monthly	Monthly
Chhattisgarh	Real-time	NA	Weekly	Weekly	Monthly	Monthly	Monthly
Delhi	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Goa	Real-time	NA	Real-time	Monthly	Monthly	Monthly	Monthly
Gujarat	Daily	Daily	Monthly	Monthly	Monthly	Monthly	Monthly
Haryana	Real-time	Real-time	Real-time	Real-time	Monthly	Monthly	Monthly
Himachal Pradesh	NA	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Jharkhand	Daily	Daily	Weekly	Weekly	Monthly	Monthly	Monthly
Karnataka	Daily	NA	Daily	Weekly	Monthly	Monthly	Monthly
Kerala	Real-time	NA	Real-time	Real-time	Monthly	Monthly	Monthly
Madhya Pradesh	Real-time	NA	Real-time	Real-time	Monthly	Monthly	Monthly
Maharashtra	Real-time	Real-time	Real-time	Real-time	Monthly	Monthly	Monthly
Manipur	Real-time	NA	Weekly	Monthly	Monthly	Monthly	Monthly
Meghalaya	Daily	NA	Daily	Daily	Monthly	Monthly	Monthly
Mizoram	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Nagaland	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Odisha	Daily	NA	Daily	Daily	Monthly	Monthly	Weekly
Punjab	Real-time	Real-time	Real-time	Monthly	Monthly	Monthly	Monthly
Rajasthan	Real-time	NA	Real-time	Monthly	Monthly	Monthly	Monthly
Sikkim	Monthly	NA	Monthly	Monthly	Monthly	Monthly	Monthly
Tamil Nadu	Real-time	NA	Real-time	Real-time	Weekly	Weekly	Weekly
Telangana	Real-time	Real-time	Real-time	Daily	Weekly	Weekly	Weekly
Tripura	Real-time	NA	Real-time	Monthly	Monthly	Monthly	Monthly
Uttar Pradesh	Real-time	NA	Real-time	Weekly	Monthly	Monthly	Monthly
Uttarakhand	Daily	Daily	Daily	Daily	Monthly	Monthly	Monthly
West Bengal	Real-time	NA	Real-time	Real-time	Monthly	Monthly	Monthly

Source: (4)

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