Ministry of Health & Family Welfare
Government of India

Techno-Economic Assessment of Electronic Vaccine Intelligence Network

December 2018

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सचिव
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Secretary

सत्यमेव जयते

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Government of India
Department of Health and Family Welfare
Ministry of Health & Family Welfare

Date: 15th January, 2019

MESSAGE

The Universal Immunization Programme (UIP) provides free of cost vaccination to more than 2.5 crore infants and around three crore pregnant women every year through approximately 27,000 cold chain points situated across the country. The Government of India has taken several routine immunization strengthening measures to ensure vaccination of each and every child. The Electronic Vaccine Intelligence Network (eVIN) —one of these measures—aims to support UIP while digitizing vaccine stocks and by monitoring real-time temperature of the cold chain through a smartphone application.

eVIN has set up a strong example of how technology can be leveraged to enhance efficiency and effectiveness of the public health measures. eVIN plays a significant role in delivering vaccines in adequate quantity at recommended temperature to the beneficiary. States are benefitting with the implementation of eVIN and have been able to improve planning, temperature monitoring, management of stocks and distribution of vaccines to the last mile. Currently, eVIN has been implemented in 12 states of the country and a further expansion is planned in remaining 24 states/union territories.

An assessment of the programmatic effectiveness, return on investment and the magnitude of savings was planned to help policy and program managers for better planning and allocation of resources. Various aspects of programmatic implementation have been assessed through quantitative and qualitative methodology. Through the economic assessment, the study highlights significance of return of investment and how the programme can be further scaled up.

Results of the assessment are encouraging and corroborate the eVIN achievements. However, there are gaps, which need to be addressed to further optimize the benefits of eVIN implementation. I am hopeful that the report provides an integrated solution to address inequities in vaccine coverage by supporting state governments in overcoming constraints of infrastructure, monitoring and management information systems and human resources. I commend the team at the Immunization Division within the Ministry, who has contributed immensely to this report and the work by our states which have successfully rolled out the eVIN initiative. I look forward to all states and UTs implementing this important initiative towards ensuring a high quality Immunization programme across the country.

(Preeti Sudan) 15/1/19

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MESSAGE

To set a benchmark in the field of immunization through enhanced use of technology in monitoring the programme, the Electronic Vaccine Intelligence Network (eVIN) has been developed by Ministry of Health, Government of India.

eVIN (Electronic Vaccine Intelligence Network) is a technology system that digitizes vaccine stocks and monitors the temperature of the cold chain through a smartphone application. eVIN aims to support the Government of India's Universal Immunization Programme by providing real-time information on vaccine stocks and flows, and storage temperatures across all cold chain points in the twelve implemented states.

Integrating innovation with health care, eVIN aims to strengthen the vaccine supply chain to ensure equity in vaccine availability. It also improves policy-making in vaccine delivery, procurement and planning for new antigens. The techno-economic assessment of eVIN suggests that the eVIN system is playing a pivotal role in effective and efficient management of vaccine supply, supervision and monitoring. The findings of this assessment suggest significant positive changes in the areas of vaccine stock management, wastage, utilization and documentation.

I take this opportunity to applaud all contributors involved in the development of this report. I am sure the report will be useful in developing a national monitoring and evaluation framework for the immunization programme, course correction in vaccine management processes and in ensuring efficient temperature monitoring at cold chain points. This will be also useful in promoting improved efficiency of vaccine and cold chain management by upscaling eVIN in the remaining states.

(Manoj Jhalani)

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FOREWORD

The Universal Immunization Programme has contributed significantly in increasing immunization coverage in the country. The Government of India has taken intensive efforts, like Mission Indradhanush and Intensified Mission Indradhanush, to reach each and every child and pregnant women with its focus upon unvaccinated and partially vaccinated ones in hard-to-reach & high-risk population. In order to reach each and every child in the country, one of the biggest challenges has been the absence of real-time information on vaccine stocks and flows to make informed decisions.

The Electronic Vaccine Intelligence Network (eVIN) has been developed by Ministry of Health to support the Universal Immunization Programme by real-time monitoring of vaccine stock, its flow and the storage temperature across all cold chain points and to reduce the missed opportunities thereby contributing in achieving the goal of 90% full immunization coverage across India. eVIN has currently been implemented across 12 states of the country with Gavi HSS1 support (2015-17) and aims to deliver vaccines in right quantity, right quality, at right time and right temperature. Before its further scale-up in the remaining 24 states/union territories, a programmatic and economic assessment has helped to identify the achievements and the gaps.

The programmatic assessment suggests that eVIN has helped in significantly reducing the stock-out situation, wastage of vaccines, and led the way to better vaccine management practices. Most importantly the analysis of missed opportunities due to reduction in stock-outs reveals that after implementation of eVIN, fewer beneficiaries are getting omitted due to stock-out as compared in the pre-eVIN period. eVIN has also empowered the cold chain handlers by building technical capacities and providing a robust decision-making tool for cold chain managers through a complete overview of vaccine replenishment times, supply and consumption patterns. The economic assessment estimation showed that in future an investment of one-rupee in eVIN will yield a return of INR 2.91.

By streamlining the vaccine flow network, eVIN is a powerful contribution to strengthening health systems and ensures equity through easy and timely availability of vaccines to all children. I congratulate each and every person associated with this report and urge the balance 24 states to successfully roll out eVIN in their states.

(Vandana Gurnani)

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Preface

Immunization against vaccine preventable childhood diseases is the right of each and every child. India, being a signatory of Sustainable Development Goals (SDG), is committed to achieve SDG3 encompassing target of infant mortality rate below 25/1000 live births. The Universal Immunization Programme of the country is one intervention with the potential to achieve the desired target. It is one of the largest public health programme in the world, which caters to a birth cohort of 2.6 crore infants and around 3 crore pregnant women every year utilizing a cold chain network of more than 27,000 cold chain points with 95% of it situated below the district level. This is not a small task in a nation with the largest and most ambitious immunization program in the world which aims to immunize this huge birth cohort.

In 2015, India implemented the electronic vaccine intelligence network (eVIN) –an indigenous, smart and easy-to-use technology– aimed at digitizing vaccine stocks in the country. eVIN empowers the state cold chain network by building the capacities of cold chain handlers; and deploying vaccine and cold chain managers in every district for constant support to estimate vaccine requirements, supervise cold chain handlers and coordinate with cold chain technicians across the district. eVIN empowers the cold chain handlers by building technical capacities, while providing a robust decision-making tool for cold chain managers through a complete overview of vaccine replenishment times, supply and consumption patterns.

eVIN is presently being implemented by the central government in 12 states representing more than 60 percent of the target population. Running the technology beyond the initial implementation is now being embedded in the budgets of state governments. ITSU undertook the techno economic assessment of eVIN, which has helped us in determining the return on investment (RoI) on every rupee spent on this technology and I am happy to share that for all the eVIN states a return of investment of INR 1.41 in first year of implementation and 2.91 in subsequent years.

I am thankful to the experts at ITSU, who contributed to the development of this document. I hope this document will be incorporated in providing solutions to address the extensive inequities in vaccine coverage and also confirms the well-timed availability of vaccines.

(Dr. Pradeep Haldar)

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Introduction

India's immunization program is not without its challenges. The country's vast and diverse terrain makes reaching the poorest and most vulnerable a monumental effort. Perhaps the biggest challenge has been the absence of real-time information on vaccine stocks and flows, so that health officials are able to make quick and informed decisions.

The innovative Electronic Vaccine Intelligence Network (eVIN) is at present being implemented across 12 states of India. The technology aims to support the Government's Immunization Program by providing real time information on vaccine stock and flows, and storage temperature across all cold chain points in these states. The technological innovation is implemented by Ministry of Health and Family Welfare, Govt. of India and UNDP being the implementing partner. Integrating innovation with health care, eVIN aims to strengthen the vaccine supply chain to ensure equity in vaccine availability.

The techno economic evaluation has been an extensive exercise which has brought to light several benefits of eVIN programmatically and economically. The findings of the assessment reveal that after the implementation of eVIN there has been savings in utilization of vaccines, better stock management practices leading to the lesser percentage of facilities witnessing stock-out of any antigen, reduction in avoidable wastage of vaccine doses, better vaccine management and temperature monitoring.

I am confident that this report would be helpful to use at national, state, district levels to improve the quality of vaccine supply chain services. I convey my best wishes to each and every person associated in preparation of this report and look forward to its future success.

(Dr. M.K. Aggarwal)

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ACRONYMS

ANM	Auxiliary Nurse Midwife
AS	Assam
BCG	Bacillus Calmette–Guérin
BR	Bihar
CCH	Cold Chain Handler
CCL	Cold Chain Logistics
CCO	Cold Chain Officer
CCE	Cold Chain Equipment
CCT	Cold Chain Technician (Refrigerator Mechanic)
CG	Chhattisgarh
CHC	Community Health Center
DH	District Hospital
DF	Deep Freezer
DIO	District Immunization Officer
DPT	Diphtheria, Pertussis, Tetanus
DQA	Data Quality Assessment
DVS	District Vaccine Store
FEFO	First Expiry First Out
eVIN	Electronic Vaccine Intelligence Network
FIC	Full Immunization Coverage
FIFO	First-in-First-out
GAVI	Global Alliance for Vaccine and Immunization
GJ	Gujarat
GMSD	Government Medical Store Depot
GoI	Government of India
HF	Health Facility
HepB	Hepatitis B
HiB	Haemophilus Influenzae type-B
HMIS	Health Management Information System
HP	Himachal Pradesh
HSS	Health System Strengthening
ILR	Ice Lined Refrigerator
IPV	Inactivated Polio Vaccine
ISCL	Immunization Supply Chain and Logistics

ITSU	Immunization Technical Support Unit
JE	Japanese Encephalitis
JH	Jharkhand
MN	Manipur
MP	Madhya Pradesh
MR	Measles-Rubella
MoHFW	Ministry of Health and Family Welfare
MO	Medial Officer
NCCMIS	National Cold Chain Management Information System
NCCVMRC	National Cold Chain and Vaccine Management Resource Centre
NG	Nagaland
NHM	National Health Mission
OR	Odisha
OPV	Oral Polio Vaccine
PHC	Primary Health Center
Penta	Pentavalent Vaccine
PIP	Program Implementation Plan
PPM	Planned Preventive Maintenance
PO	Project Officer
PCV	Pneumococcal Conjugate Vaccine
RCH	Reproductive and Child Health
ROI	Return On Investment
RVS	Regional Vaccine Store
RJ	Rajasthan
RVV	Rotavirus Vaccine
SIO	State Immunization Officer
SPO	State Program Officer
SDH	Sub District Hospital
SC	Sub-Centre
SVS	State Vaccine Store
TT	Tetanus Toxoid
UIP	Universal Immunization Program
UNDP	United Nations Development Program
UP	Uttar Pradesh
VCCM	Vaccine and Cold Chain Manager
VVM	Vaccine Vial Monitor
WHO	World Health Organization

EXECUTIVE SUMMARY

The success of Universal Immunization Program (UIP) lies in its ability to deliver safe and potent vaccines to the last beneficiary. To do so, it relies on the network of cold chain facilities spread across the country. In 2015, Government of India introduced Electronic Vaccine Intelligence Network (eVIN), a new age indigenous technology, which enabled real-time visibility of stock and temperature of cold chain equipment across the country. With Gavi HSS1 support (2015-17), eVIN has been implemented in 12[a] out of 36 states/union territories of India. Gavi HSS2 support (2017-21) will enable introduction of eVIN in the remaining 24 states/union territories.

Following the roll-out, state governments are expected to sustain its implementation costs from the year 2018 onwards. Even as the roll-out of eVIN is through Gavi's support, it is important to understand the actual cost of implementation and the cost to scale up. In the purview of the due roll-out in remaining states, an assessment of the programmatic effectiveness, return on investment and the cost of saving will help policy and program managers to better plan and allocate resources. This techno-economic assessment provides the evidence on programmatic and economic aspects of eVIN implementation.

For the purposes mentioned above, both primary and secondary data sources have been utilized. Data from Immunization Division, MoHFW, and UNDP-Delhi office were used as indicators on savings in vaccine utilization, vaccine wastage, and return on investment. For measures like stock management, temperature monitoring, cold chain equipment and record keeping, descriptive, cross-sectional study design with mixed method approach was utilized to collect six months data[b] each before and after the introduction of eVIN (pre-eVIN vs post-eVIN) from 617 cold chain points (CCPs) across 12 eVIN states. However, a comparative study of three eVIN and three non-eVIN states covering 444 cold chain points was also aimed, due to possibility of non-availability of data in the pre-eVIN period for indicators such as temperature monitoring, document accuracy, and cold chain equipment status etc.

For economic assessment, specialized data with economic expertise was collected from randomly selected 102 cold chain points (CCPs) of seven eVIN states. The vaccines considered in this report are: Hep-B, BCG, OPV, DPT, Pentavalent, Measles, and TT for all 12 states, except Himachal Pradesh where Measles was not included due to introduction of MR vaccine during the observation period. Based on the analysis of the primary and secondary data sources, key findings are listed in the next section.

Programmatic Assessment Findings

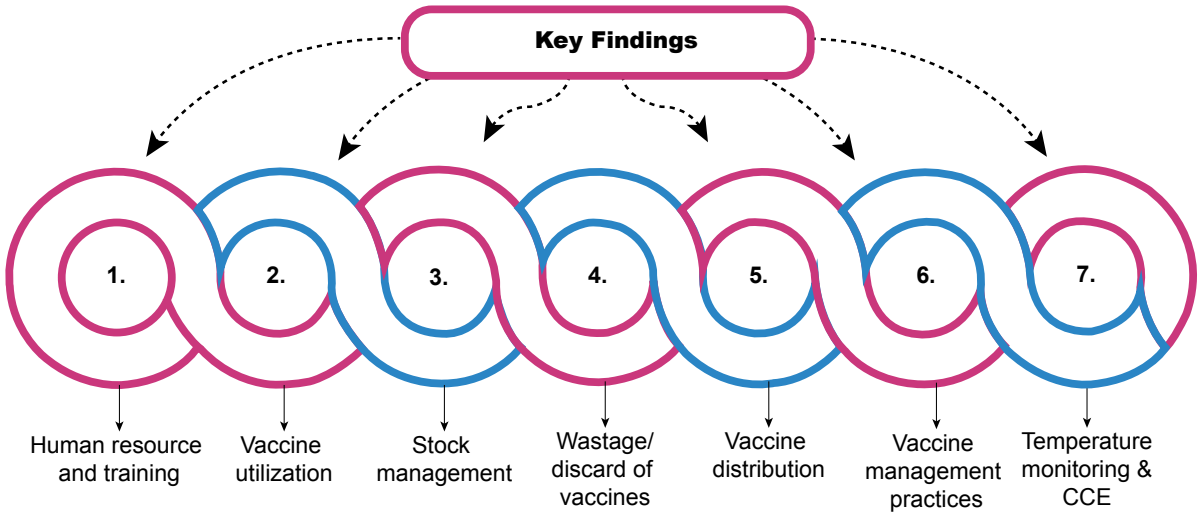
The study focuses on programmatic and economic assessment of the eVIN implementation. Various aspects of programmatic implementation have been assessed through quantitative and qualitative methodology. In the economic assessment, the study presents estimation of return on investment and the cost of scaling-up.

[a]The 12 states where eVIN has been rolled-out are: Uttar Pradesh, Rajasthan, Madhya Pradesh, Assam, Nagaland, Manipur, Bihar, Jharkhand, Chhattisgarh, Odisha, Gujarat and Himachal Pradesh.
[b]Reference period in primary data collection for pre eVIN was 6 months prior to the inception of eVIN, and for post eVIN it was Oct'17 to Mar'18.

Quantitative Findings

The key findings are focusing on seven areas as shown in the figure 1:

Figure 1: Thematic areas of key findings



Human Resource and Training

Success of any framework lies with their beneficiaries. Similarly, vaccine and cold chain managers/cold chain handlers across immunization supply chain are the interface across all levels. In all 12 eVIN states, primary cold chain handlers were present at all CCPs. However, back-up CCH was reported only at 30% of the facilities as reported by MOIC of the facility. The physical or administrative presence of backup CCH was not verified during the assessment.

In eVIN states, around 40% of CCHs were above the age of 50 years; around 39% are above 55 years who will retire in couple of years. Noticeably, more than 50% of CCHs in Jharkhand and Odisha fall in the age group of 50+ years. Moreover, only 50% of the CCHs have been working for more than three years, and the rest have recently started working. The qualitative feedback from program managers suggest that there should be some provision for retaining the CCHs at the same CCP or replacing them with trained CCH only.

Across 12 eVIN states, 90% CCHs reported to be trained on new vaccine and cold chain handler (VCCH) module, and 94% primary CCHs have received training on eVIN modules. Most of the CCHs (70%) received their training more than a year ago. However, in non-eVIN states, 44% CCHs are above 50 years of age; of which 74% reported to be trained on VCCH module.

Savings in utilization of vaccines

The vaccine utilization data of Immunization Division, MoHFW reflects that the utilization has reduced from 3,053 lakh doses in pre-eVIN period to 2,149 lakh doses in post-eVIN period across 12 eVIN states, resulting into savings of approximately 900 lakh (90 million) doses of vaccines. These savings can be attributed to the roll-out of eVIN across12 states, and other initiatives such as the introduction of open vial policy, effective vaccine management assessments, and continuous follow-up with an improvement plan in place. The roll-out of eVIN has effectively improved the visibility of stock till last cold chain point and has also led to better vaccine management practices such as reduction in vaccine wastage and stock-out events.

Stock Management

The primary data collected from 617 CCPs across 12 eVIN states suggest that the percentage of facilities witnessing stock-out of any antigen has reduced from 37.8% in pre-eVIN period[c] to 26.3% in post-eVIN period leading to

[c]Reference period in primary data collection for pre eVIN was 6 months prior to the inception of eVIN, and for post eVIN it was Oct'17 to Mar'18.

30% reduction in facilities reporting stock-outs. The instances of stock-out of any antigen has also curtailed from 1 instance/CCP in pre-eVIN to 0.6 instance/CCP in post-eVIN, leading to a reduction of 40% in instances of stock-out. Similarly, the number of days of stock-out has reduced from 13.1 days/CCP in pre-eVIN phase to 8.3 days/CCP in post-eVIN phase, resulting into 37% reduction in the number of days of stock-out.

The study has not reported any statistically significant improvement in the areas of minimum and maximum stock management situations. The minimum stock of any antigen was observed at 49.8% facilities in the pre-eVIN period, compared to 47.8% facilities in the post-eVIN period that shows about 4% reduction in the minimum stock. Moreover, facilities' observing maximum stock of any antigen has increased from 37.4% in pre-eVIN to 39.2% in post-eVIN indicating a 5% increase in facilities witnessing events of maximum stock.

The analysis of missed opportunities due to reduction in stock-outs reveals that after implementation of eVIN, fewer beneficiaries are getting omitted due to stock-out as compared in the pre-eVIN period. The highest reduction was observed in DPT (reduced by 70%), and lowest in BCG (reduced by 6%) and almost no change in Hep-B (reduced by 0.2%) after eVIN implementation.

Wastage of Vaccines

Another critical finding has been the reduction in avoidable wastage of vaccine doses (unopened vials). The secondary data analysis of UNDP records suggests that the facilities reporting wastage of any vaccine have reduced from 30% in pre-eVIN period to 22.6% in the post-eVIN period, indicating a 25% reduction in wastage of any vaccine due to reasons such as non-usable vaccine vial monitor (VVM), freezing, expiry and broken vials (data source: UNDP reported eVIN and VCCM records). The highest reduction in avoidable wastage was observed for DPT (reduced by 98.7%) and the lowest was observed for OPV (reduced by 21.9%) after the implementation of eVIN.

Vaccine Distribution

The distribution system is a mix of push and pull across all levels of immunization supply chain. The effectiveness of a distribution system lies in lesser replenishment time, complete order fill rate[d] and minimal expiry of vaccines at stores. In pre-eVIN period, it took seven days in getting supplies from a higher-level store, which has now reduced to three days, even though, order fill rate remained almost unchanged (from 97% in pre-eVIN to 99% in post-eVIN). Furthermore, mean number of days (of vaccine expiry) has reduced from 428 in pre-eVIN to 384 in the post-eVIN, at CCP level signifying that the 'First Expiry First Out' (FEFO) is being practiced.

It was also found that the lateral sharing, which is CCP to CCP transfer of vaccines, is practiced across all the cold chain points. The results suggest that there is a reduction in lateral sharing across eVIN states. For example, around 5 lakh (0.5 million) doses was shared in pre-eVIN phase in comparison to around 4.4 lakh (0.4 million) doses in the post-eVIN phase. This finding might be a result of excess stock at the facilities, and the dual efforts to manage expiry of vaccines as well.

Vaccine Management Practices

Documentation

For stock management, use of standardized stock registers by CCHs has increased from 56% in pre-eVIN to 97% in post-eVIN period. The updating of vaccine stock register (either daily or weekly) has improved from 54% in pre-eVIN to 81% in the post-eVIN period, reflecting an overall improvement in vaccine management practices.

Completeness

The completeness of record keeping was checked against applicable fields of the register[e]. The vaccine stock registers, having more than 90% completeness, has increased from 29% facilities in pre-eVIN period as compared to 75% facilities in the post-eVIN period. The temperature log books, with almost all the fields completed has increased from

[d]Order fill rate = (Quantity Received/Quantity Indented)*100

[e] Registers checked were stock register, indent register and temperature log book

28.5% facilities to 69.8% facilities. Similarly, indent registers with almost all fields completed, has increased from 26% facilities to 69% facilities in the observation period.

Accuracy

Records were also found to be accurate when matched with the physical count of the vaccines. During accuracy check across 12 states, 94% accuracy was observed in the stock registers and eVIN entries. Similarly, 92% accuracy was observed in the physical counting of doses and eVIN entries.

Record-keeping Practices

Comparison of time taken by CCHs to update the information pertaining to vaccine stock management in their individual registers and in the eVIN system was done for both eVIN and non-eVIN states. It was observed across eVIN states that whenever CCHs updated their records, it took an additional 24 minutes in preparing the indent, 20 minutes in updating the vaccine issue and receipt information, and additional 44 minutes in updating the distribution records in contrast to substantially lesser time taken in updating all these details in registers across non-eVIN states.

Temperature Monitoring

Vaccines are stored at the recommended temperature to ensure their potency. Hence, temperature monitoring and health of cold chain equipment need a lot of attention. These indicators were difficult to analyze both in pre and post comparison stages as a result, the set of eVIN states were compared with matching non-eVIN states. Findings indicate that in eVIN states, 97% CCHs are ensuring the recording of temperature on the same day in comparison to 81.8% CCHs in non-eVIN states. Also, temperature loggers were matched with the stem thermometer in eVIN states, and in 88% of the cases, both instruments matched within a permissible error of +/- 0.5 degree Celsius.

Cold Chain Equipment (CCE)

Findings also suggest that upkeep time of cold chain equipment is better in eVIN states vs non-eVIN states. Equipment across eVIN states have reported sickness rate of 1.9% which is within the acceptable GoI permissible scope of up to 2%, whereas the sickness rate in non-eVIN states was reported to be 3.4%, which is way higher than the set standard norms.

Qualitative Findings

This assessment tried to gain insights from the key stakeholders on their perception of the financial and programmatic sustainability of the program. Majority of the stakeholders believed that financial support is needed for running the technology equipped program. They recommended additional funding for repairing of the cold chain equipment (CCE), mobile phones, replacement of faulty equipment and/or mobile phones, and the costing for these repairs to be included in Program Implementation Plan (PIP).

Officials at national and state level emphasized on key components to corroborate sustainability. For strengthening the present human resource, they suggested that additional CCHs should be appointed and trained exclusively on eVIN system. Furthermore, they suggested that there should be guidelines to retain CCHs at his/her own CCP or they should be replaced by a trained CCH only. Absorption of VCCM by National Health Mission (NHM) was appreciated by almost all the stakeholders and they considered this essential for the sustainability of the programme.

They further suggested the need to ensure availability of appropriate infrastructure facilities such as physical space, electricity and power back-up. They also suggested increasing the supportive supervision with a biometric system at each CCP to contribute in achieving sustainability. Another suggestion was to introduce updated and improved equipment with pre-installed data loggers and defined position of sensors.

Economic Assessment Findings

Analysis of utilization data (for the assessed seven vaccines) from the ministry, showed that the highest cost saving from vaccines in the post-eVIN period was in Uttar Pradesh (INR 32.76 crore) followed by Bihar (INR 30.23 crore). Both these states also showed a positive return on investment. While in Uttar Pradesh, one rupee investment in eVIN yields return of investment of INR 1.27; in Bihar, return on one rupee investment yield is INR 1.83. Taking into consideration all the eVIN states together, the return of investment is INR 0.52. This return of investment (ROI) however did not consider the new vaccines that were introduced post-eVIN implementation period, such as rotavirus, IPV, PCV and MR. If the new vaccines were added in the calculation (considering 80% coverage of all these vaccines and applying the average saving from existing vaccines) the finding would lead to additional saving of INR 162 crore and a return of investment of INR 1.41, when considering all eVIN states together.

While assessing recurring expenses, certain startup costs will not recur as the programme progresses. Analysis of recurrent expenses related to eVIN, and the savings including for all new vaccines, the return on investment significantly increases for Bihar and Uttar Pradesh. The analysis further show that one-rupee investment in eVIN will give more than six times the return in these two states. As the programme progresses, it is suggested seven more states will also have a positive return from eVIN. Furthermore, it is suggested that two states: Manipur and Nagaland will not have a positive ROI owning the reasons to the population size of these two states. While considering all the 11* eVIN states together, it is estimated that in the future an investment of one-rupee in eVIN will yield a return of INR 2.91.

The ROI analysis was carried out using the government's perspective on ROI as the basis for economic assessment. The cost of illness that was averted because of missed opportunity was only considered and therefore the amount of saving was found not to be significant. Several reasons are attributed for the low-cost saving from the missed opportunity. Firstly, the unavailability of the costs for many of the vaccine preventable diseases such as diphtheria, tetanus, pertussis and measles in the Indian context; secondly, the limited use of only the government perspective as the basis for the economic assessment. It is suggested that societal perspective should also be considered in addition to the government's perspective when assessing economic assessments for higher savings. Extending the parameters of the assessment would then include savings from productivity loss, premature mortality, and additional savings from other vaccine-preventable diseases.

Following implementation of eVIN, additional recommended cost savings methods include visibility of vaccine stock position, better management of OPV during the tOPV to bOPV switch, distribution of several near to expiry DPT vaccines for better utilization, and temperature alerts to save several vaccines from contamination and early expiry. These suggested recommendations could have some cost implications and may lead to cost savings; however, these suggestions cannot be validated because of the lack of pre-eVIN data on the same.

Recommendations

eVIN has set up a strong example of how technology can be leveraged to enhance efficiency and effectiveness of the public health measures. States are benefitting with the implementation of eVIN and have been able to improve planning, temperature monitoring, management of stocks and distribution of vaccines to the last mile. Results of the assessment are encouraging and corroborate these achievements. However, there are gaps, which need to be addressed to further optimize the benefits of eVIN implementation.

- The cold chain handlers are the backbone of the vaccine supply chain. Routine and frequent transfers of CCHs are a key concern for effective cold chain management. States are recommended to take necessary steps to ensure limited transfers of trained cold chain handlers to increase their productivity for longer durations in the same role.

*Since there was no expenditure for Himachal Pradesh during 2014-17, the investment related to eVIN was calculated for the remaining 11 states.

- Overall, facilities observing stock-out of any vaccine have significantly reduced after the introduction of eVIN, but the instances of minimum and maximum stock remain unimproved. Despite the reduction in stock-out, 26.3% facilities still observed stock-out in the post-eVIN phase. There can be several underlying factors affecting the stock-out situation, however, it is highly recommended to include:
  - Strict guidelines either to follow push or pull mechanism, unanimously by states on a timely basis
  - Order management module at the national level
  - Rigorous monitoring the optimal use of eVIN technology for maintaining stocks
  - Guidelines for realistic estimates of the target population vs. actual requirement of vaccines at each CCP
- A proper monitoring system to be put in place to monitor and review the wastage of vaccines and staff to be encouraged to report wastage along with the related cause.
- Clear guidelines need to be in place to discourage rational CCP to CCP sharing of vaccines across the vaccine supply chain.

1 INTRODUCTION

1.1 Background

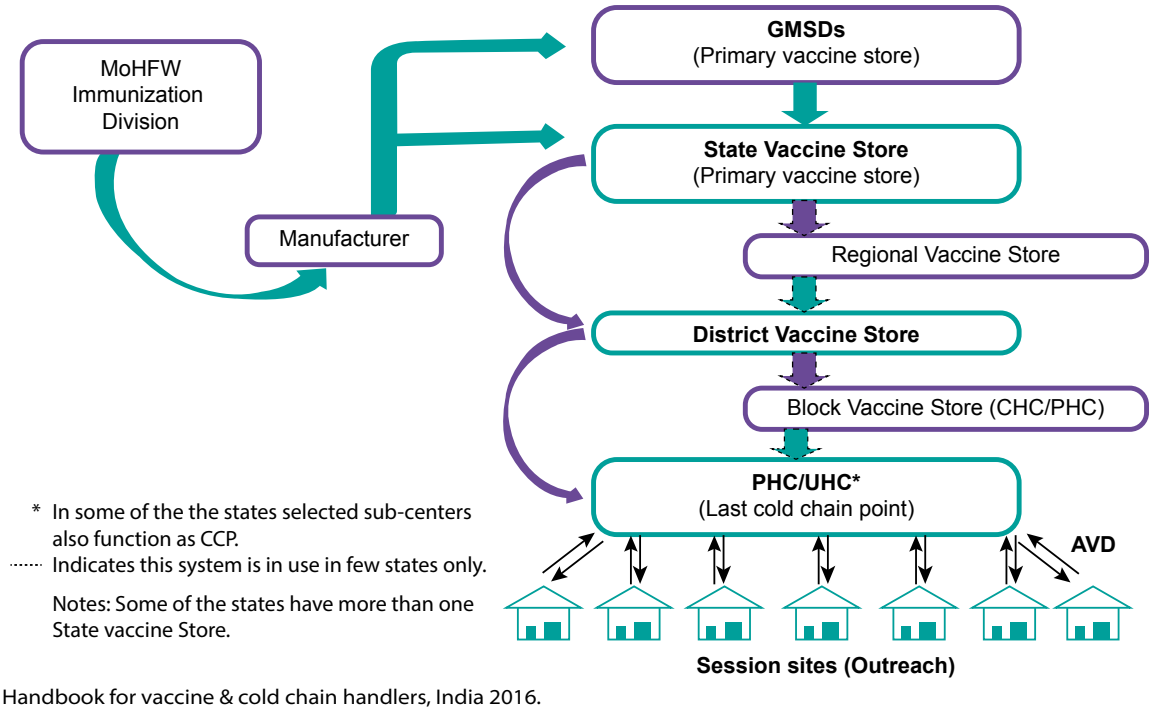
The Immunization Supply Chain and Logistics (ISCL) system, which is the backbone of an immunization program, plays a key role in improving the immunization coverage with quality and equity through timely supply of safe and potent vaccines. In a public sector immunization programme, it is mandatory to provide the right vaccines in the right quantity, in the right condition, at the right time, in the right place and at the right supply chain cost[1]. The universal immunization programme (UIP) of India, one of the largest public health programmes in the world, caters to ~2.6 crore new born and ~3 crore pregnant women in 90 lakh sessions every year through 27,000 cold chain points[2]. The ISCL system in the country has played a significant role in achieving the current coverage levels while dealing with the challenges in vaccine storage, distribution and management. India's ISCL system faces the challenges of infrastructure, monitoring and management information systems, and constraints of human resources, including technical capacities[3]. The rapidly changing landscape of UIP demands for more monitoring and investments to keep pace with the introduction of newer and costlier vaccines and in switching of one vaccine to another[4].

Immunization Supply Chain Network

Under UIP, the vast cold chain network ensures storage and transportation of vaccines at optimal temperature from manufacturers until the peripheral health facility. This network comprises of four national level Government Medical Store Depots (GMSDs) each at Karnal, Mumbai, Chennai and Kolkata; state, regional and district level vaccine stores; and cold chain points located at Community Health Centers; Primary Health Centers; Urban Health Centres; and even at Sub-centers across the country. This network consists of ~27,000 cold chain points, of which~95% are located at the sub-district level.

As shown in the Figure 2, manufacturer supplies the vaccines to the GMSDs and to State Vaccine Stores (SVSs) located in Northern, Western, Eastern and Southern parts of the country respectively. SVSs further receive vaccines directly from the manufacturer as well as from GMSDs, and some states have multiple state vaccine stores located beyond the state headquarters. From SVSs, vaccines are further supplied down to Regional Vaccine Stores (RVS) and from there on to the District Vaccine Store (DVS). In the absence of RVS, vaccines are directly sent from SVS to the DVS and are then distributed to the CHC/PHC/UHC/last cold chain point.[f]

Figure 2: Vaccine Supply Chain in India



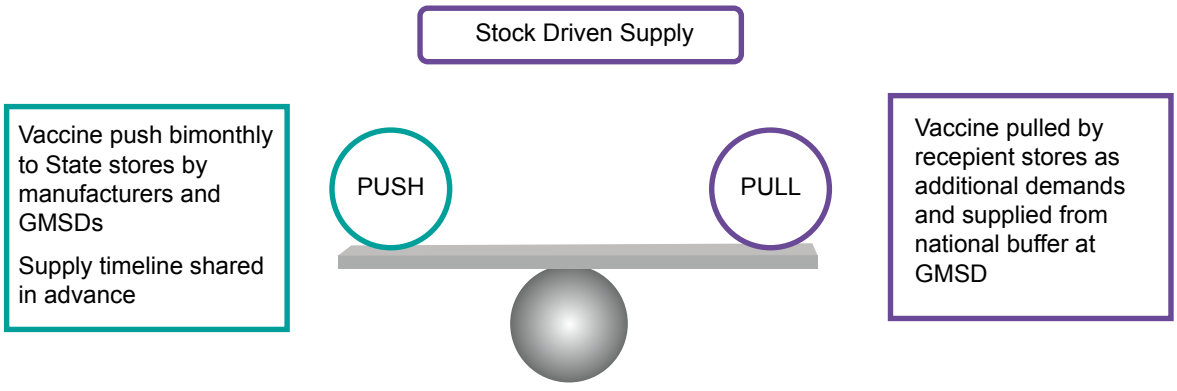
Source: Handbook for vaccine & cold chain handlers, India 2016.

[f]Cold chain points are basically the facilities which receive vaccines from DVSs and distribute vaccines to the session sites on session days.

Vaccine Distribution Mechanism

Vaccine distribution in India relies on push and pull mechanism as described in Figure 3. The vaccine stocks, by and large, are 'pushed' down from higher to the lower level (e.g. GMSDs and manufacturers at the national level to the SVSs), and thereafter to levels further down. However, in situations of additional vaccines requirement at the lower level, a demand for vaccines is raised from the lower level to the higher level (e.g. from the state to national level) and vaccines are pulled out and supplied from buffer stock at GMSD level to the state. Supply chain equilibrium is therefore maintained by this push-pull mechanism. The vaccine stock oscillates between 1-3 months depending on the level of the store.

Figure 3: Push and Pull Mechanism in Vaccine Supply Chain



Source: Immunization division, Ministry of Health & Family Welfare. 2017. India's experience with immunization supply chain strengthening. 15th TechNet Conference, Portugal, 16th-20th October, 2017

Issues in Vaccine & Cold Chain Logistics System

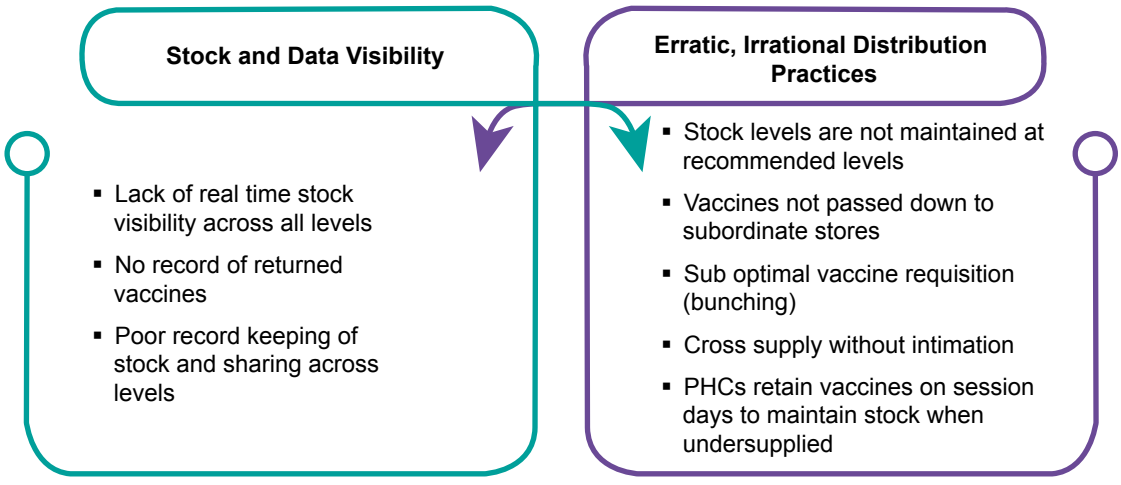
In India, four types of paper formats[g] are used for recording temperature, maintenance and repair details of cold chain equipment (CCE), for the vaccine stock, daily issue and logistics indent[5]. These formats require manual data entry, compilation and consolidation, which leads to a time lag and lack of real-time visibility of stock levels and temperatures. Overstocking and stock-outs of vaccines may occur because of the lack of real-time vaccine stock visibility, weak inventory and stock-flow record keeping practices; and the absence of distribution planning by qualified personnel. Moreover, the temperature monitoring of CCE is largely dependent on the availability of a dedicated human resource at the cold chain point (CCP). This type of system maintenance poses serious challenges to the quality of recording, reporting and monitoring temperature of CCEs.

In addition, there are several issues pertaining to poor record keeping, use of non-standardized stock registers and distribution practices. For example, stock levels are currently not maintained leading to frequent stock-outs, retention of vaccine vials at last cold chain points due to limited stock or single vial availability leading to increased number of missed opportunity within the target population and irrational distribution of vaccines for unjustified demands.

These limitations often affect vaccine distribution leading to wastage, over-stocking and stock-outs, thereby hindering complete and effective vaccine coverage. Inconsistent distribution practices result in cross sharing of vaccines between cold chain points without any communication to higher store in-charge. The following figures 4 and 5 sums up the important and significant supply vs. distribution challenges, which requires immediate attention.

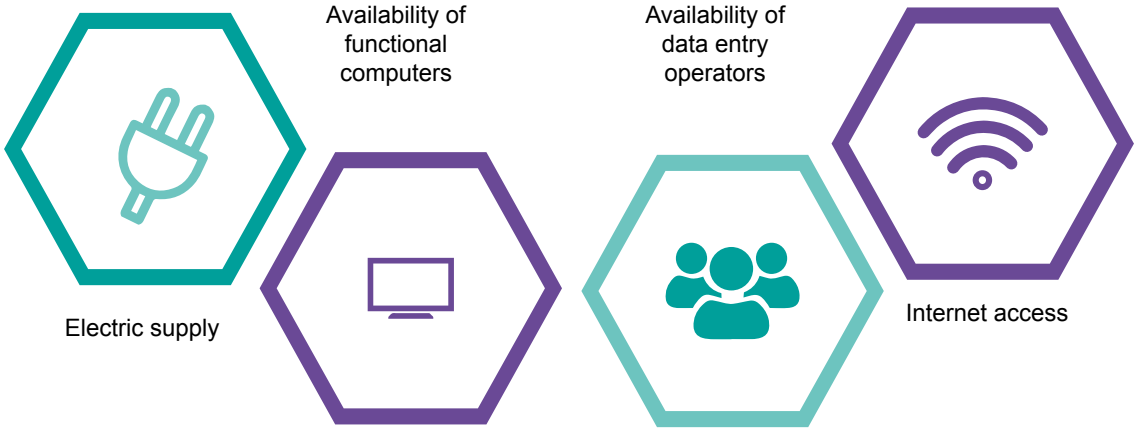
[g]The four types of formats used to manage cold chain include: a) comprehensive log book for every cold chain equipment (CCE) to record temperature and also record details of repair and maintenance, b) vaccine stock register- issue and receipt, c) vaccine distribution register for immunization session, and d) vaccine and logistics indent form.

Figure 4: Issues in Vaccine Logistics in India



Apart from the procedural challenges, there are additional challenges across the earlier cold chain points. Lack of power supply or extended power failures for more than 8 hours; poor internet connectivity in outreach or hard-to-reach areas due to limited availability of service providers; poor availability of IT infrastructure; lack of data entry operators and the issue of distance from the district store are some other challenges in management of cold chain at the peripheral level[6]. With the introduction of new expensive vaccines under UIP, the ISCL will need to be strengthened to ensure accessibility to and use of effective vaccines.

Figure 5: Challenges at the level of Health Facilities



Advent of Electronic Vaccine Intelligence Network (eVIN)

An efficient, real time visibility at all levels is important to ensure uninterrupted supply, at optimal temperatures while taking into consideration a short shelf life of vaccines compared to other drugs. The real time visibility also facilitates in events of shocks such a slow yield and batch failure. In the wake of these challenges, Electronic Vaccine Intelligence Network (eVIN), was indigenously developed by the Immunization Technical Support Unit (ITSU). eVIN is a technology system that digitizes vaccine stocks through a smartphone application and builds the capacity of program managers and cold chain handlers to integrate technology in their regular work. eVIN technology uses the smartphone, web-based application, temperature loggers and cloud-based server to digitize vaccine stock inventory and storage temperature from every vaccine store and cold chain points located at peripheral government health facilities.

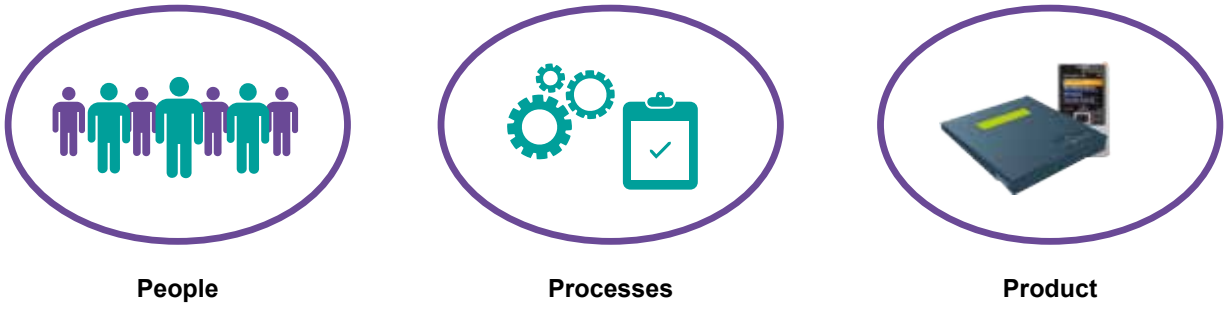
eVIN was piloted in Bareilly and Shajahanpur districts of Uttar Pradesh in 2014. After testing the capability of eVIN in providing real-time visibility of stocks and temperature of cold chain equipment, the technology was rolled out by

United Nation's Development Programme (UNDP) using the Gavi, Health System Strengthening (HSS) support. As of date, it has been rolled out in a phase wise manner across12 states of the country.

What is eVIN?

eVIN is an integrated package of people, process and product (Figure 6). UNDP has ensured the capacity development of cold chain handlers (people) for successful implementation of the eVIN system. eVIN is a combination of software and SIM-enabled temperature loggers (product) specially designed to improve vaccine stock keeping practices and temperature monitoring (processes) across eVIN states.

Figure 6: The three integral parts of eVIN

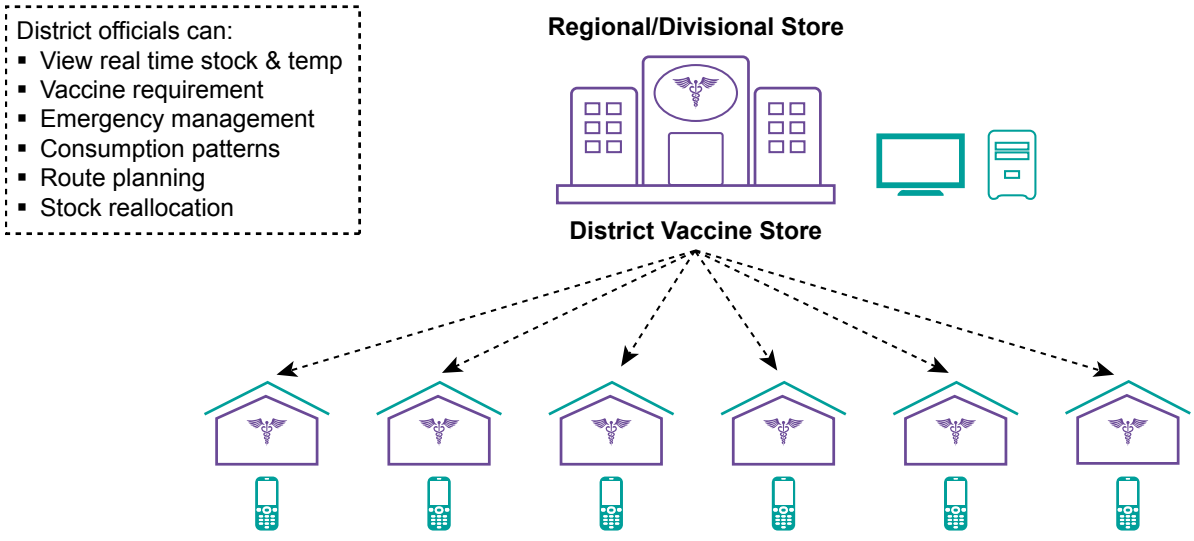


How Does it Work?

All cold chain handlers are provided smartphones having eVIN application that allows for the digitization of vaccine inventories (Figure 7). As a routine task, every cold chain handler enters the net utilization for each vaccine in the standardized registers at the end of every immunization day. This is simultaneously updated in the eVIN application and uploaded on a cloud server, which can then be viewed by programme managers at district, state and national level through online dashboards.

SIM-enabled temperature loggers attached to the cold chain equipment capture temperature information through a digital sensor placed in the ILR/DF. Temperature data is recorded every ten minutes and updated at an interval of sixty minutes on the server via General Packet Radio Service (GPRS). In case of temperature breach, the logger alarms and sends an email and SMS alerts to responsible cold chain technicians and managers.

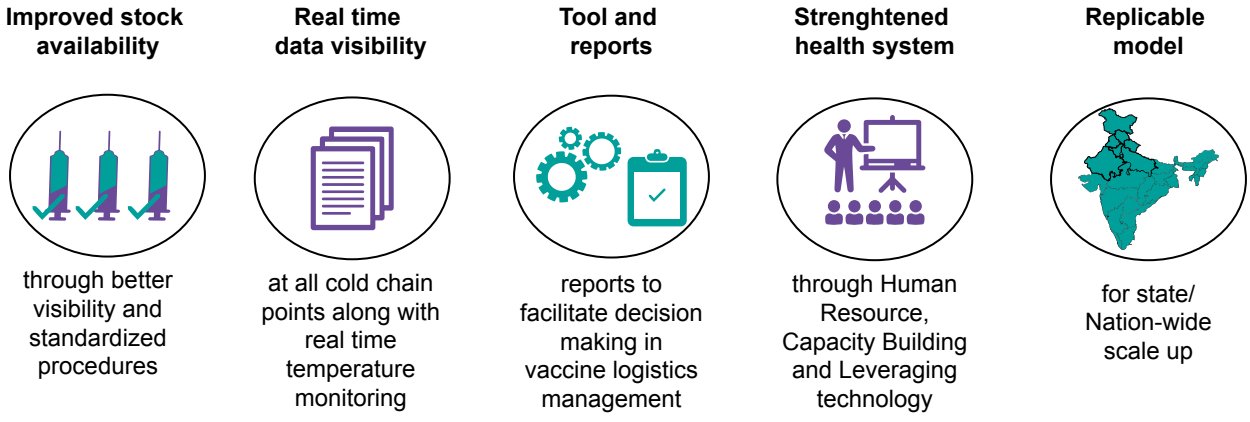
Figure 7: The functioning of eVIN



Perceived Benefits

eVIN combines state-of-the-art technology, standardized record-keeping practices and a strong network of trained personnel to address widespread inequities in vaccine coverage and it supports the state governments in overcoming constraints of infrastructure, monitoring and management information systems and human resources, often resulting in overstocking and stock-outs of vaccines in cold chain points. eVIN has created a big data architecture that generates actionable analytics across 20 major indicators encouraging data-driven decision making, accountability and a positive behavioral change in the public health system. Vaccine availability at all times has increased significantly in most cold chain points since the introduction of eVIN along with a significant reduction in vaccine wastage (Figure 8).

Figure 8: Expected benefits of eVIN



Vaccine Logistics Management: eVIN states vs non-eVIN states

Significant improvement in Vaccine Logistics Management is observed across all the states after the introduction of eVIN implementation. However, across non-eVIN states, vaccine logistics management needs to increase focus in improving stock management practices[7]. Currently the practices followed are:

- Manual Stock Management
- Limited visibility of vaccine stock till National and state stores
- Challenge in remote temperature monitoring of electronic CCEs
- Manual indenting , and the demands of the lower store are not based on consumption
- No automatic system of alert for vaccine near to expiry date
- Improper and longer holding of stock at stores
- Distribution is not based on consumption

1.2 Rationale of the Study

Under Gavi HSS1 support (2015-17), eVIN was implemented in 12 out of 36 states in India with the state governments sustaining the programme through their own funding mechanism. Gavi HSS2 support (2017-21) enabled the introduction of eVIN in the remaining 24 states and union territories but from the year 2018 onwards, state governments were expected to sustain its own implementation costs.

Further, though several immunization supply chain studies including the "National Effective Vaccine Management (EVM) Assessment" by the National Cold Chain Vaccine Management Resource Centre has been conducted on vaccine and cold chain management, no assessment studies have been conducted on the implementation of eVIN and its programmatic outcomes.

Given this context, the 'Techno-economic assessment of eVIN' was proposed to provide learnings for scale up of the progarmme in remaining states, and also pave a sustainable way forward for eventual transition of eVIN from UNDP/ GAVI to GoI. The study aims to provide evidence on programmatic and economic benefits of eVIN system.

1.3 Study Objectives

The study objectives of the Techno-Economic Assessment of Electronic Vaccine Intelligence Network (eVIN) are to:

1. Assess the programmatic usefulness of eVIN implementation, in areas of stock management, documentation, temperature monitoring and functionality of cold chain equipment.
2. Document the program benefits and challenges of eVIN implementation, in contributing to system effectiveness and efficiencies.
3. Evaluate the economic impact of eVIN implementation, including cost savings on vaccine and cold chain logistics management.
4. Conduct an economic-feasibility assessment modeling the Return On Investment (ROI) of eVIN implementation.

2 METHODOLOGY

2.1 Study Design

For implementation of this assessment, both primary and secondary data sources were utilized. The primary data had both quantitative and qualitative components, whereas secondary data had only the quantitative component. The secondary data sources such as the Immunization Division, MoHFW, and UNDP-India were utilized for indicators on pipeline stock, wastage, and return on investment. For economic evaluation, data was collected from randomly selected 102 cold chain points (CCPs) from 7 eVIN states. The vaccines considered in this report are: Hep-B, BCG, OPV, DPT, Pentavalent, Measles, and TT for all 12 states, except for Himachal Pradesh where Measles was not included due to introduction of MR vaccine during the observation period.

There were three distinct components to the study:

- Pre- and post-implementation assessment: To assess the programmatic usefulness of eVIN, a pre-eVIN versus post-eVIN comparative analysis was carried out on key performance indicators for all the 12 eVIN states. eVIN was implemented at different points of time for different states. Obtaining data for one year time period prior to implementation of eVIN was challenging. Hence, data for six months in eVIN state was chosen as the reference period for pre-eVIN phase (Annexure-1). The period from October 2017 to March 2018 was selected as the reference period for collection of data sets for the post eVIN period. The study also captured perspectives of various stakeholders to understand their role at different levels of the vaccine supply chain management. Quantitative data was obtained from cold chain points pertaining to stock management, temperature monitoring, cold chain equipment, and documentation aspects of vaccine supply chain.
- A comparative study in 3 eVIN and 3 non-eVIN states: A comparative analysis of key performance indicators (KPIs) was carried out to assess if there are enhanced outcomes in eVIN states as compared to non-eVIN states. Three non-eVIN states which were similar in characteristics to eVIN states in terms of levels of full immunization, number of cold chain points, number of CCPs with power supply of <8 hrs, and cold chain sickness rate were selected.
- Economic assessment: For economic assessment of eVIN implementation, data was collected from 102 CCPs across 7 states: Assam (19 CCPs); Chhattisgarh (12 CCPs); Gujarat (15 CCPs); Jharkhand (11 CCPs); Nagaland (7 CCPs); Odisha (20 CCPs); Rajasthan (18 CCPs) during the period of April-June 2018, using a structured questionnaire. Information was collected from the vaccine stock registers and by interviewing the cold chain handlers of the respective CCPs.

2.2 Sample Size and Sampling Technique for Programmatic Assessment

Quantitative Methodolgy

For pre- and post-assessment of eVIN, number of cold chain points was estimated using proportion of stock-outs at the peripheral health facilities (according to National EVM Assessment-2013, 43% of PHCs had reported instances of stock-out)[8].

Estimation of Cold Chain Points to be Included in the Assessment

The minimum number of CCPs, without any adjustment, was calculated using following formula:

$$n = \frac{(Z^2 * p * q)}{d^2}$$

Where, z = 1.96 (i.e. 95% Confidence Interval); p = 43%; q = 1-p; d = 5%; Based on this, sample of cold chain points to be included was 376. After adjusting for 10% non-response rate and 1.2 design effect[9], sample size was estimated to be 496.

Adjustment in sample size: To draw conclusions at the level of the state, the sample size was further increased to 620 CCPs from 12 eVIN states for a pre-post study design. The selected CCPs were distributed across all 12 eVIN states based on relative proportion of CCPs in each state.

Sampling Technique for Pre - and Post - Study Design in eVIN States

All eVIN states were selected for pre- and post-design. For the selection of CCPs, two-stage sampling technique was deployed; the first stage for selecting districts, followed by selection of CCPs in the second stage.

Stage 1 - Selection of districts: Within each eVIN state, districts were selected based on Probability Proportional to Size Sampling (PPS).

- The total number of selected districts in 12 eVIN states was 37. Based on relative proportion of each state, the number of districts to be sampled was: Assam (3), Chhattisgarh (3), Gujarat (3), Jharkhand (2), Manipur (1), Nagaland (1), Odisha (3), Bihar (4), Himachal Pradesh (1), Madhya Pradesh (5), Rajasthan (3), and Uttar Pradesh (8).
- The districts were arranged in ascending order based on the proportionate share of cold chain points out of the total cold chain point in the state. An interval (N/n) factor was calculated by dividing the number of total districts (N) in the region by the number of districts (n) to be selected. After selecting the first district randomly, every (N/n)th district was selected until the required number for districts was obtained. The details on sample selected are available in Table 1.

Stage 2: Selection of Cold Chain Points: Cold chain points were randomly selected in each of the selected district.

Table 1: State and district wise number of sampled cold chain points

State	Total number of CCPs	Numbers of selected CCPs	Sample districts	Numbers of CCPs in each district
Assam	730	44	1. Dhubri 2. Jorhat 3. Nagaon	11 15 18
Chhattisgarh	525	31	1. Balod 2. Kawardha 3. Dhrampuri	13 07 11
Gujarat	2093	124	1. Porbandar 2. Panchmahal 3. Kheda	12 52 60
Jharkhand	225	13	1. Dumka 2. Dhanbad	6 7
Manipur	95	6	1. Imphal West	6
Nagaland	100	6	1. Kohima	6
Odisha	1161	70	1. Nuapada 2. Jajpur 3. Baleshwar	12 25 33
Bihar	615	37	1. Jamui 2. Patna 3. Lakhisarai 4. Nalanda	09 06 06 16
Himachal Pradesh	386	23	1. Shimla	23

Contd...

State	Total number of CCPs	Numbers of selected CCPs	Sample districts	Numbers of CCPs in each district
Madhya Pradesh	1127	68	1. Hoshangabad	15
			2. Vidisha	16
			3. Chhindwara	7
			4. Alirajpur	14
			5. Betul	16
Rajasthan	2214	132	1. Bharatpur	43
			2. Chittorgarh	44
			3. Bikaner	45
Uttar Pradesh	1096	66	1. Varanasi	06
			2. Shahjahpur	08
			3. Ghaziabad	12
			4. Gorakhpur	15
			5. Kushinagar	7
			6. Basti	7
			7. Unnao	8
			8. Shravasti	3
Total	**10367**	**620**	**37**	**620**

Sampling Technique for comparative study in 3 eVIN and 3 non-eVIN states

For the comparison of eVIN and non-eVIN states, three-stage sampling was done for the selection of states, districts, and cold chain points.

Stage 1 - Selection of states (eVIN and non-eVIN): For the comparative assessment of outcome indicators between eVIN and non-eVIN states, eVIN states were selected randomly. Among the non-eVIN states, three states, with similar characteristics in terms of full immunization coverage, number of CCPs, number of CCPs having less than 8 hours of power supply, and cold chain equipment sickness rate, were selected. For eVIN and non-eVIN comparison, non-eVIN states of Haryana, West Bengal, and Punjab were selected for the comparison with eVIN states of Bihar, Madhya Pradesh, and Chhattisgarh, respectively. The list of matching indicators for 3 eVIN vs 3 non-eVIN states are listed in Table 2.

Table 2: Matching indicators among eVIN and non-eVIN states

	State	CCP[h]	Immunization coverage[i]	Sickness rate[j]	Power supply of less than 8 hours[k]
eVIN	Bihar	615	61.7	1.7	61
Non-eVIN	Haryana	586	62.7	1.3	58
eVIN	Madhya Pradesh	1127	53.6	1.6	13
Non-eVIN	West Bengal	915	84.4	0.1	4
eVIN	Chhattisgarh	525	76.0	0.6	6
Non-eVIN	Punjab	722	89.0	0.4	5

[h]National Cold Chain – Management Information System (NCC-MIS)
[i]National Family Health Survey (NFHS), 2015-16 (BCG, measles, and 3 doses each of polio and DPT) (%)
[j]This is the proportion of cold chain equipment out of order at any point of time
[k]Power supply for at least 8 hours in a day is necessary for functioning of cold chain equipment.

Sample Size Estimation for eVIN vs non-eVIN states

$$n = \frac{(Z^2 * p * q)}{d^2}$$

Where, z=1.96; p= Proportion of stock-out at facility (43%); q= 1-p; d= 7% (Table 3)

Based on this, sample of cold chain points was 192. After adjusting for a design effect of 1.2 the total CCPs were 230 each from eVIN and non-eVIN states.

Table 3: Calculation of sample size for comparison of eVIN and non-eVIN states

Health Facility	p	q	d2	CI	Sample
Sample Size without adjustment	0.43	0.57	7%	95%	192
Adjusted sample size (1.2 design effect)			230		

This sample of 230 CCPs eVIN states was compared with an equal sample of 230 CCPs in non-eVIN states. For operational feasibility, out of 230 CCPs in the eVIN states, nearly 60% of the CCP (i.e. 136) were same as those selected for pre- and post-assessment, while remaining 40% (i.e. 94) were selected besides those selected earlier.

Stage 2 - Selection of districts in eVIN and non-eVIN states: For eVIN states, same districts which were selected for pre- and post-assessment were also taken for the comparative assessment. For non-eVIN states, same technique (PPS) was adopted for the selection of districts (Table 4).

Stage 3 - Selection of CCPs: The CCPs were selected randomly in each of the district.

Table 4: Distribution of sample in non-eVIN States

State	CCPs	Sample CCPs	Districts
West Bengal	915	95	Paschim Bardhaman
			North 24 Pargana
Punjab	722	75	Ludhiana Jalandhar Sangrur
Haryana	586	60	Hisar Yamuna Nagar

Total Sample for Programmatic Assessment

Total sample of 944 CCPs from 44 districts was selected for the assessment across 12 eVIN and 3 non-eVIN states. The details are tabulated below in Table 5:

Table 5: Total Sample for both pre- and post- eVIN, and eVIN Vs non-eVIN study design

Type of study	No. of selected cold chain points	Remarks
Pre-eVIN and post-eVIN	620	620 CCP in 37 districts of 12 eVIN states
eVIN vs non-eVIN	230 + 230	460 CCP distributed equally among 3 eVIN and 3 non-eVIN states (230 in each group)

Reference Period in Programmatic Assessment

In the primary data collected for programmatic assessment, the observation period for pre-eVIN was six months prior to the implementation of eVIN in a state. For post-eVIN and eVIN/non-eVIN, the observation period for all 12 and 3 states (12 eVIN and 3 non-eVIN) was kept uniform from Oct'2017 to Mar'2018.

The primary data was collected for a period of six months each, due to possibility of non-availability of registers for a longer period in pre-eVIN phase. However, the pre-eVIN observation period differed from state to state as it was rolled out in a phase wise manner across the states.

In order to achieve the target sample, replacement of CCPs was done due to non-availability of pre-eVIN period stock registers, distribution registers and other important registers. The replaced CCPs were selected randomly from the list of remaining CCPs.

Qualitative Methodology

In-depth interviews were conducted with relevant stakeholders in all 12 eVIN and 3 non-eVIN states. Qualitative interviews at the National, State, Regional, and District levels were conducted by a team of two interviewers. The details are given in Figure 9.

Figure 9: Data collection Tools for key stakeholders across the supply Chain

	eVIN system stakeholders	Non-eVIN system stakeholders	Type of tool
National Level	DC-Immunization		Qualitative/Quantitative
	Chief-Health & Development, UNDP-Delhi		Qualitative/Quantitative
State Level	MD-NHM	MD-NHM	Qualitative
	State Immunization Officer	State Immunization Officer	Qualitative
	State Cold Chain Officer	State Cold Chain Officer	Qualitative
	State Program Officer (UNDP)	NA	Qualitative
	State Vaccine Store Manager/In charge	State Vaccine Store Manager/In charge	Quantitative
Regional Level	Regional Director/ Additional Director	Regional Director/Additional Director	Qualitative
	Cold Chain Technicians	Cold Chain Technicians	Qualitative
	Regional Program Manager (UNDP)	NA	Qualitative
	Regional Vaccine Store Manager/In-charge	Regional Vaccine Store Manager/In-charge	Quantitative
District Level	District Immunization Officer	District Immunization Officer	Qualitative
	Cold Chain Technicians	Cold Chain Technicians	Qualitative
	Vaccine Cold Chain Manager (UNDP)	NA	Qualitative
	District Vaccine Store Manager/In charge	District Vaccine Store Manager/In charge	Quantitative
Facility Level	MOIC	MOIC	Quantitative
	Cold Chain Handler	Cold Chain Handler	Quantitative

2.3 Sample Size and Sampling Technique for Economic Assessment

For economic assessment, two data sets were used. First, the data set was collected by two members team from 102 randomly selected cold chain points (CCPs) of seven states: Assam (19 CCPs); Chhattisgarh (12 CCPs); Gujarat

(15 CCPs); Jharkhand (11 CCPs); Nagaland (7 CCPs); Odisha (20 CCPs); Rajasthan (18 CCPs) during the period of April – June 2018.

Another data set used for economic assessment was the data gathered for programmatic assessment, data shared by UNDP and immunization division of the union ministry of health and family welfare. It is to be noted here that the definition of pre- and post-eVIN period was different at the time of data collection from the 102 CCPs for economic assessment and the data obtained from ministry/UNDP and other sources. Hence, these two results are not strictly comparable. However, both the datasets have been used to understand the difference in return on investment.

For the data collected for the economic assessment, pre-eVIN period was defined as one year prior to eVIN implementation in the state. Post-eVIN period was defined as one year post eVIN implementation in the state. For example, if eVIN started in October 2016, October 2015 to September 2016 was considered as pre-eVIN period and October 2016 to September 2017 was considered post-eVIN period.

2.4 Study Tools

Study tools were developed through a consultative process after a thorough review of the existing literature. Due consideration has been given to the overall objectives of the assessment, available data sources, and components emphasized in similar studies conducted in the past to assess health system strengthening interventions. Data sources included but were not limited to the vaccine stock registers, vaccine indents/vouchers, eVIN reports and interviews with various groups of stakeholders.

Similar tools were used in both components viz.a.viz pre- and post-eVIN assessment and for comparison between eVIN and non-eVIN states.

Quantitative Tools

This included a questionnaire for district vaccine store managers and cold chain handlers at CCPs and comprised of closed- as well as open-ended questions.

Qualitative Tools

These tools comprised of specifically designed open-ended questions to guide interviews and discussions with different groups of stakeholders as given in Figure 9.

Economic Assessment Tools

For economic evaluation, a structured questionnaire was used for data collection. Data was collected from the vaccine stock registers and by interviewing the cold chain handlers of the respective CCPs.

2.5 Ethical Aspects

The study protocol, along with all quantitative and qualitative tools developed for the assessment, was submitted for ethical approval from the "Institutional Ethics Review Board" (IERB) of Sigma Research and Consulting Pvt. Ltd., Delhi.

Informed consent was taken, and confidentiality and security of data was ensured. Based on the inputs from the Board, study tools were revised and resubmitted. Training of field investigators and data collection was started after the receipt of ethical approval from the IERB.

2.6 Training and Pre-Testing

a. Training of Field Investigators and Supervisors

Following topics were covered during training;

- Immunization related technical areas: Basics of cold chain equipment, concepts behind vaccine stock management, and eVIN stakeholders at various levels.
- Sensitization on the tool (questionnaire): interview skills, in-depth understanding regarding the components covered in the questionnaire and the expected information.
- Field visit for hands-on practice regarding tool execution.
    - Debriefing: discussion of feedback from the field visit, and tool execution, and assessment of interviewers' knowledge.

b. Pre-testing

All qualitative and quantitative tools were pre-tested in one district each of eVIN state (Bulandshahar, Uttar Pradesh) and non-eVIN state (Sonipat, Haryana). At both these locations, interviews were conducted with the medical officers and cold chain handlers to assess the feasibility of introducing the tools, specificity of queries, sequencing, and assess possible challenges during the data collection. Based on the pre-test findings, necessary modifications were done in the tools and methodology of the assessment.

2.7 Data Collection: Time and Processing

Data collection for programmatic assessment was carried out between May and July 2018. For quantitative data collection, CAPI or "Computer Assisted Personal Interviewing" technique was employed using tablets/mobiles for application based online data entry. This ensured the quality of data collection and elimination of time involved in data entry. This also helped in omitting chances of error during data entry from hard copies. Furthermore, time duration and date of filing of a form was also captured.

Data Processing

The data processing for this assessment was done in survey CTO and in MS Excel, which involved data entry, data cleaning, and cross-checking of entries. In addition, a random check of 5% of electronic data was matched with the photos of registers of receptive CCPs.

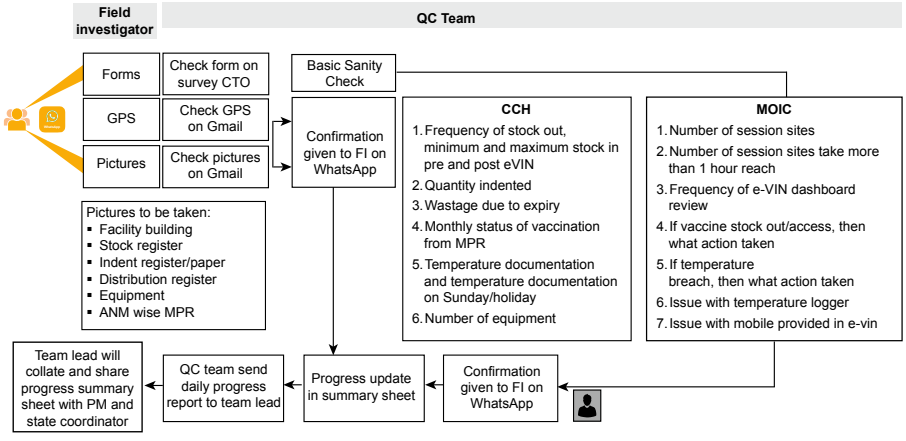
Data Security

The data sets did not include names of any stakeholders or any other information that would allow identification of respondents. All physical copies of filled questionnaires and field notes were kept secure and confidential. All electronic data, including audio files, have been stored on a password-protected computer while back-up of all data and analysis reports have been stored on an external encrypted hard drive.

2.8 Quality Assurance Mechanism

For quality assurance in data collection, backend teams regularly checked the data and GPS location of field investigators on a daily basis. Any discrepancy/error was rectified in a timely manner. Figure 10 explains the steps used for maintaining quality assurance in data collection.

Figure 10: Quality Assurance Process



To avoid skipping of data fields by field investigators (FIs), checks were incorporated during uploading of tools on the Survey CTO application. Additionally, 5% of sample data was matched with photographs of registers clicked during the data collection process to ensure the quality of data and to rectify discrepancy, where required.

A few supervisory visits by data collection agency were conducted to ensure the quality of data collection and to manage field challenges.

Independent Monitoring visits by ITSU

To ensure quality of the data collected, independent monitoring visits were conducted by ITSU members in all 15 states. The feedback received from the field monitors were shared on a regular basis and the needed remedial actions were incorporated in a timely manner by the agency thereafter.

2.9 Detail on Sample Collected

Data collection for programmatic assessment was carried out between May and July 2018 using various assessment tools. The table below provides the details of the data collected for pre-vs post-analysis and eVIN vs non-eVIN comparison. Despite repeated efforts, the study could collect data from 926 cold chain points as against the target sample of 944 CCPs. For the pre- and post- study design, 126 CCPs were replaced due to non-availability of required registers/documents pertaining to pre-eVIN phase. Out of the selected sample of 620 CCPs for pre- and post-eVIN analysis, data was collected for 617 cold chain points. Similarly, out of 460 sampled CCPs for comparative assessment in eVIN and non-eVIN states, data for 444 (222 in eVIN + 222 in non-eVIN) CCPs was made available (Table 6 and Table 7).

Table 6: Status of data collected: Quantitative

S. No.	Details	Numbers
1.	Total CCPs	944
2.	Data collected*	926
3.	Data collected in eVIN states for Pre and Post Design	617/620
4.	Data collected for comparative assessment in eVIN vs. Non-eVIN states	(222# + 222)/ (230 + 230)

*Out of 617 CCPs, 126 CCPs were replaced due to non-availability of registers of pre-eVIN phase
#Out of 222 CCPs needed for comparative assessment in eVIN states, 137 CCPs were covered in pre- and post-study design

Table 7: Stakeholders interviewed for quantitative data collection

State	CCP Covered	Remarks
eVIN states		
Assam	44	
Bihar	63	37 CCP for pre/post and 26 for eVIN/non-eVIN
Chhattisgarh	52	31 CCP for pre/post and 21 for eVIN/non-eVIN
Gujarat	124	
Himachal Pradesh	23	
Jharkhand	13	
Madhya Pradesh	115	68 CCP for pre/post and 47 for eVIN/non-eVIN
Manipur	6	
Nagaland	6	
Odisha	70	
Rajasthan	132	
Uttar Pradesh	66	
Non- eVIN states		
Haryana	60	
West Bengal	95	
Punjab	75	
Total CCHs	**944**	

A total of 182 qualitative interviews were conducted against the target of 226 due to non-availability of respondents or their prior engagements (Table 8 and 9). The maximum drop was observed at the regional level due to unavailability or vacancy of officials (PO UNDP).

Table 8: Status of data collection: Qualitative

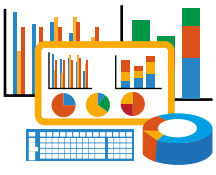
	National	State	Region	District	Total
Planned	2	57	42	125	226
Completed	2	45	21	114	182

Table 9: Stakeholders interviewed for qualitative data collection

States	Total districts selected	State Level (MD, SIO, SCCO, SPO-UNDP)	Regional (MO, CCT, PO-UNDP)	District Level (DIO, CCT, UNDP, VCCM)	Total state-holders at district level	Total Stakeholders
eVIN States						
Himachal Pradesh	1	1	3	3	3	10
Rajasthan	3	4	3	3	9	16
Uttar Pradesh	8	4	3	3	24	31
Odisha	3	4	3	3	9	16
Assam	3	4	3	3	9	16
Nagaland	1	4	3	3	3	10

States	Total districts selected	State Level (MD, SIO, SCCO, SPO-UNDP)	Regional (MO, CCT, PO-UNDP)	District Level (DIO, CCT, UNDP, VCCM)	Total state-holders at district level	Total Stakeholders
Chhattisgarh	3	4	3	3	9	16
Jharkhand	2	4	3	3	6	13
Madhya Pradesh	5	4	3	3	15	22
Bihar	4	4	3	3	12	19
Manipur	1	4	3	3	3	10
Gujarat	3	4	3	3	9	16
Non-eVIN states						0
Haryana	2	3	2	2	4	9
West Bengal	2	3	2	2	4	9
Punjab	3	3	2	2	6	11
Total	**44**	**57**	**42**	**42**	**125**	**224**
			Stakeholder's Interviewed at national level			2
					Grand Total	**226**

The above table depicts a total of 226 stakeholders selected for interviews at the District, Regional, State and National levels.

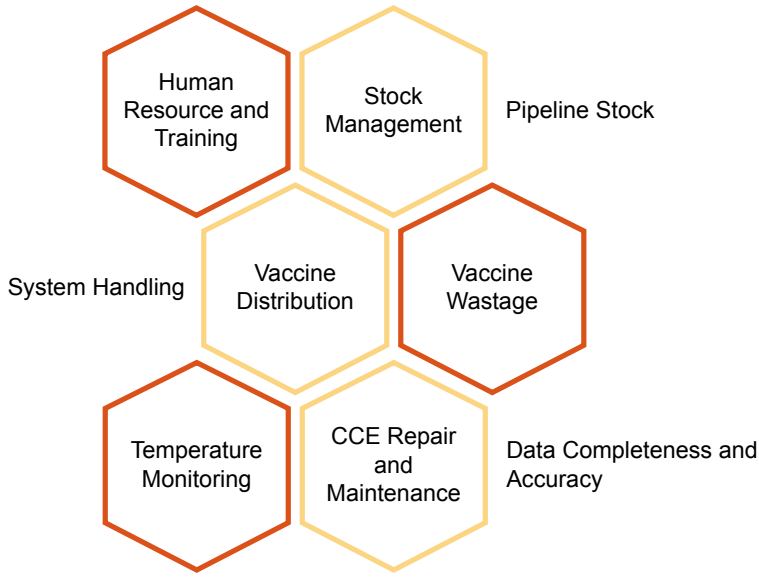


2.10 Data Analysis

a. Quantitative Data Analysis

Quantitative analysis was carried out using Excel, STATA 13 and ATLAS.ti software. The results are presented in descriptive, bi-variate form comparing pre- vs post or eVIN vs non-eVIN findings. Statistical significance of the percentage change during and pre- and post-implementation of eVIN was also conducted. This was done using proportion test at 95% confidence interval. The programmatic analysis focused on nine key parameters mentioned in the below Figure 11:

Figure 11: Key Parameters for Programmatic Assessment



b. Qualitative Data Analysis

ATLAS.ti and thematic analysis approach were used to analyze information gathered from key stakeholder interviews and analyzed on the following parameters:

- Performance of eVIN on stock management and forecasting
- Improved visibility of stocks at different levels of the supply chain
- Use of data to inform programmatic and resourcing decisions
- Perceived benefits & challenges
- Monitoring and review mechanism
- Timeliness of reporting from states, data accuracy
- Data visibility for management decision-making
- Sustainability of eVIN

Indicators, Data Sources and Study Design

Due to non-accessibility of registers/documents at various levels, distinctive data sources were utilized for drawing the inferences as described in Table 10.

Table 10: Key Indicators, Data Source and Study Design

Indicators	Source of Data	Study Design
HR & Training	Primary Data	Pre and Post
Vaccine Utilization	Secondary Data (from MoHFW)	Pre and Post
Stock Management	Primary & Secondary data	Pre and Post
Vaccine Wastage	Secondary data (from UNDP)	Pre and Post
Vaccine Distribution	Primary Data	Pre and Post
Vaccine Management Practices	Primary Data	Pre and Post
Documentation	Primary Data	Pre and Post
Temperature Monitoring	Primary Data	eVIN & Non-eVIN
CCE Repair and Maintenance	Primary Data	eVIN & Non-eVIN
System Handling	Primary Data	eVIN & Non-eVIN

Detailed findings related to above parameters are described in subsequent chapters.

Details on Programmatic Assessment

Vaccine Utilization

The information of vaccine supplies across 12 states was taken from the Immunization Division for three consecutive financial years: 2015-16, 2016-17 and 2017-18. The analysis incorporated data of one year preceding the inception of eVIN and one year after eVIN. As eVIN was implemented in 2015-16 in Madhya Pradesh (MP), Rajasthan and Uttar Pradesh (UP), the duration for the baseline period was different for these three states from the remaining nine states. The end line study period for understanding the savings was 2016-17 for MP, Rajasthan and UP and 2017-18 for the remaining nine states. New vaccines like MR, Rota, IPV and PCV were not considered for maintaining the uniformity in comparing pre- and post-intervention impact. Measles vaccine was not considered for Himachal Pradesh because of the introduction of MR in 2016-17. OPV vaccine supply was not considered for Uttar Pradesh, Rajasthan and Madhya Pradesh for both the years because of t-OPV to b-OPV switch and mop-up rounds in 2016-17.

Considering these factors, vaccine utilization in doses was computed as the sum of opening doses (in lakh) and doses supplied from GMSD or supplier deducting doses of closing balance. This data does not include stock pertaining to campaigns.

Missed Opportunity

In India, usually two sessions are conducted in a duration of seven days, and the number of sessions missed are in proportion of the number of Auxiliary Nurse Midwives (ANM) available at a specific health facility. Based upon this information, the number of sessions missed due to stock-outs was calculated for each of the antigen separately. If the number of days of stock-out of an antigen lasted for a minimum of three days, it was assumed that one session was missed. Two sessions were missed if the stock-out lasted for a minimum of another four days. Similarly, next session is considered missed if the stock-out lasted for another three complete days and next in another four days and likewise. The sum of missed sessions at a facility was in proportion of the total sessions conducted in the same duration at that facility. Based on the sum of days of stock-outs of vaccines, subsequent missed opportunities[1] were calculated.

The number of beneficiaries missed due to stock-out of an antigen was calculated using Health Management Information System (HMIS) data of the same duration. The average number of beneficiaries vaccinated in a session was generalized from HMIS data for each of the district and was assumed that the same numbers of beneficiaries were vaccinated at the facility as well. The sessions missed were multiplied with the number of beneficiaries vaccinated in a session at a facility.

Since Hep-B[#] vaccine is administered only at the facilities with delivery, it was assumed that every day the vaccine is getting administered and that beneficiaries are getting missed in case of stock-out. The average number of days of Hep-B stock-out was assumed to be in direct proportion of the number of facilities with institutional deliveries. To obtain the missed opportunity due to Hep-B stock-out, number of sessions missed was multiplied with the number of children vaccinated in one particular day at a delivery facility using HMIS data.

Details on Economic Assessment

The economic assessment of eVIN was conducted using economic as well as financial cost approach. While financial cost focused only on the actual expenses incurred on eVIN related activities, the economic cost represented the opportunity costs associated with the programme compared to the next best alternatives and included valuation of all inputs needed for the programme, including valuation of time, supplies, equipment etc. It used ingredients approach where all functions related to eVIN were identified and costed. Government perspective was used for the economic assessment of eVIN.

The number of trips required was calculated using the dates vaccines received in both pre- and post-eVIN period. Time spent by staff for eVIN related activities was calculated using minutes / hours spent in each activity and salary per minute / hour.

Data from the immunization division of the ministry was utilized to understand the cost savings/ dis-savings related to vaccines in the pre- and post-eVIN period. The utilization rate was considered as the difference of doses given by the centre to a state in a financial year and the opening balance reported by a state as on 1st April of each financial year. Pre-eVIN period for utilization data for Uttar Pradesh, Madhya Pradesh and Rajasthan was 2015-16 while the same for the rest of the states were 2016-17. Similarly, post-eVIN period for utilization data for these three states was 2016-17 while for the rest it was 2017-18. Due to some discrepancy in the data set, OPV has been removed from Uttar Pradesh vaccine utilization data.

State-wise investment data related to eVIN was collected from the finance division of UNDP for 11 states for the period of 2014 to 2018. As all output data was gathered till 2017, 2018 expenditure was excluded from the

[1] *Missed opportunity calculated by number of sessions missed, multiplied by number of children immunized/facility in the pre/post period from the HMIS data for the sampled districts.

[#]Hep-B is in number of days of stock-out. To calculate missed opportunity, number of days of stock-out was multiplied with the number of children immunized with Hep-B in a facility in a day in the pre/post period from HMIS data for the sampled districts.

calculations. Furthermore, even though eVIN was introduced in Himachal Pradesh, no state specific expenditure data for Himachal Pradesh during 2014-2017 was found. Therefore, Himachal Pradesh was excluded from the state level cost assessment. Apart from state-wise expenditure data related to eVIN, national level expenditure for eVIN, was also received e.g. eVIN software development and management, development of communication materials etc. were distributed equally to all 12 states.

For the calculation of missed opportunity (i.e. number of children missed immunization because of stock-out of vaccines) total number of days of stock-out was considered, and two sessions in a week (one session in 3 days and another in 4 days) were assumed. The source for stock-out data was the programme assessment data using 617 CCPs. Stock-out of any vaccine for more than 3 days means one session missed and if it was more than 7 days, then it was assumed as 2 sessions missed. The number of children was calculated from HMIS data. Number of children immunized in one session was calculated by the number of children immunized/sessions held in the observation period.

For economic assessment, estimation of the number of children at risk of different diseases pre- and post-eVIN using the missed opportunity data was assessed. Further, a literature review was carried out to understand the incidence of the disease, treatment seeking behavior and cost of illness from these diseases. The amount that could be saved from cost of illness of different diseases based on the missed opportunity data was also calculated. Largely the information for cost of illness was not available for majority of the vaccine preventable diseases in the Indian context, for instance, the cost of illness to study diphtheria, tetanus, pertussis, polio, and measles was not available. Studies related to childhood pneumonia and meningitis that could be averted by using pentavalent vaccine was found in the literature review. Therefore, the savings was calculated for these two diseases assuming the incidence rate, cost of illness etc.

2.11 Limitations/Challenges of the Study

The assessment had several limitations due to the different situations in pre- and post-eVIN period and between eVIN and non-eVIN states. These limitations/challenges are mentioned below:

1. This assessment applied three types of study design due to poor record keeping practices prevalent in pre-eVIN period, and in non-eVIN states. The assessment could not opt for one study design due to unavailability of indent registers, stock registers, distribution registers and temperature logbook pertaining to pre-eVIN period. Moreover, the assessment on some key indicators like temperature monitoring was possible only in a specific type of study design.
2. The programmatic assessment was based on seven vaccines (Hep-B, BCG, OPV, Penta, DPT, Measles and TT) which were present in the pre-eVIN and post-eVIN period. However, during the post-eVIN period, four new vaccines (Rota, PCV, IPV and MR) were introduced. These new vaccines were considered in economic assessment section, assuming similar trends of seven assessed vaccines.
3. In pre- and post-eVIN study design, 20% of the cold chain points were replaced due to non-availability of registers of pre-eVIN phase. However, the replaced CCPs were selected randomly from the list of remaining CCPs.
4. The primary data collected in the programmatic assessment considered an observation period of six months, as there was a possibility of non-availability of registers in pre-eVIN period beyond this time period. However, in economic assessment the findings of programmatic assessment were projected for 12 months assuming the same situation prevailed for another six months.
5. The eVIN was rolled out in a phase-wise manner across the states. Therefore, the time of roll-out varied among the states. The six months observation period for pre-eVIN assessment was not uniform across the states due to the differential time of roll-out across the states. However, the post-eVIN observation period and eVIN/non-eVIN comparison was kept uniform from Oct'2017 to Mar'2018.
6. In Himachal Pradesh, MR vaccine was being rolled out during the post-eVIN period. Due to the phase-out of measles vaccine in Himachal Pradesh, many instances of measles stock-out were reported in the early post-eVIN period. Hence, Measles containing vaccine (MCV) was not considered in any calculation pertaining to Himachal Pradesh.
7. As a result of tOPV to bOPV switch in 2015-16, an inflated stock of consumption was observed for the OPV stock at state levels. The year 2015-16 was also the roll-out period for eVIN in three states (MP, RJ and UP). Therefore, OPV was not considered for pre- and post-eVIN comparison in these three states (MP, RJ and UP).

3

PROGRAMMATIC ASSESSMENT

3.1 Human Resource & Training

Availability of skilled human resource is essential for making a robust and efficient system. Integration of technology in the system substantiates the need for well-trained Human Resource. To strengthen immunization programme in the country, calculation of available human resources and assessment of their capacity building needs began in 2014[10]. Cold Chain Handler (CCH) at the cold chain facility is the key personnel responsible for overall management of vaccines, logistics and cold chain, across all levels of vaccine supply chain.

Status of Primary and Back-up Cold Chain Handler

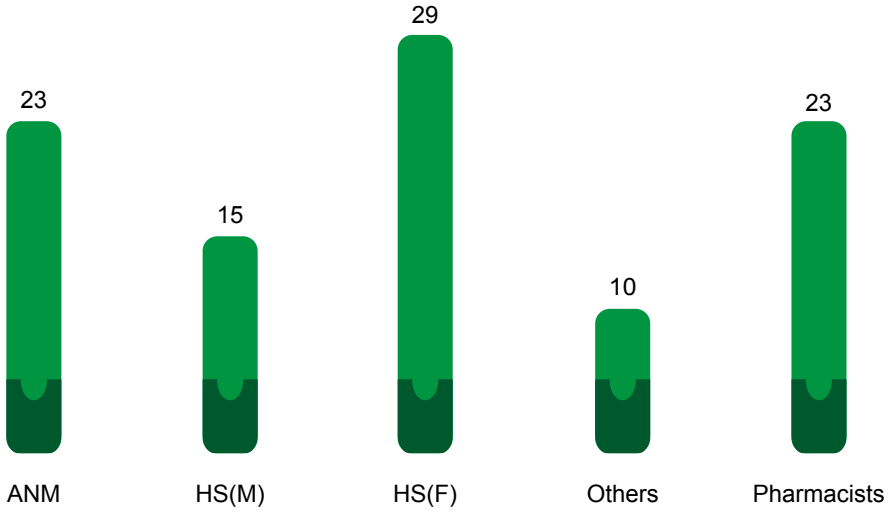
Primary cold chain handler was available at 100% of the facilities across eVIN states. Additional backup CCH across all cold chain points to oversee vaccine supplies/distribution in the absence of a primary CCH is advised, however, at present, only 30% of the facilities have additional backup CCHs across eVIN states (as per the reporting of the MOIC at the facility). However, the physical or administrative presence of backup CCH was not verified during the assessment.

Designation wise Distribution of Cold Chain Handlers

An analysis of designation of cold chain handlers revealed that (Figure12):

- Most of the ANMs or health supervisors (Female & Male; 67%) were working as CCH
- In Gujarat, 96% pharmacists were working as CCH
- Across eVIN states, 10% of the CCHs were falling into the 'other class category', signifying that they designation was other than the above specified designations
- In UP, 20% CCHs were in the 'other category', comprising of Block Health Workers and Non-Medical Assistants

Figure 12: Designation wise percentage of personnel working as Cold Chain Handlers



Age and Gender wise Distribution of Cold Chain Handler

It is apparent from Table 11 that around 40% of CCHs were over the age of 50 years. Out of which, 39% were over 55 years of age, and are due to retire in a couple of years.

- Over half the number of CCHs in Jharkhand and Odisha were above the age of 50 years
- In eVIN states, 61% CCHs were females
- In fact, 100% of CCHs in Assam and Odisha were females. While, in MP, UP, and Gujarat most of CCHs were male.

Table 11: Age wise distribution of cold chain handlers in eVIN States

State	Current age of primary cold chain handler			
	20-30 Yr. (%)	31-40 Yr. (%)	41-50 Yr. (%)	>50 Yr. (%)
Assam	2	14	39	45
Bihar	16	27	30	27
Chhattisgarh	39	19	19	23
Gujarat	48	15	23	14
Himachal Pradesh	0	17	39	43
Jharkhand	8	15	23	54
Madhya Pradesh	15	19	32	34
Manipur	0	17	33	50
Nagaland	0	33	50	17
Odisha	3	11	11	75
Rajasthan	14	20	18	48
Uttar Pradesh	18	21	20	41
Overall (N=617)	19	18	24	39

Qualitative Findings

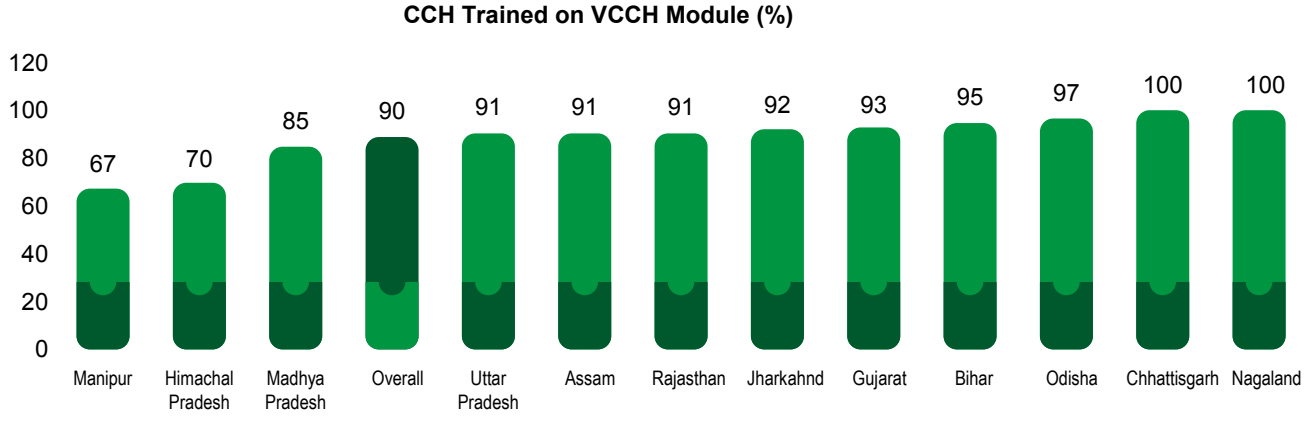
Analysis of the qualitative data revealed that cold chain handlers above the age of 50 years were committed and experienced and appreciated the benefits of eVIN technology; however, they were not proficient at using all the features of the eVIN dashboard. During interaction with CCHs, it was found that they regularly checked and responded to messages they received on their mobile from eVIN but found it difficult to use many other features of the application. Many CCHs also expressed that they seek support from their children or grandchildren for daily updating of the data. A few further mentioned that given their age, they found it difficult to use the mobile application for a longer duration as it strained their eyes. Given that most of CCHs will be retiring in the next 5-6 years, it is recommended to build a sufficient pool of CCHs in the system.

Training of CCHs

This study focused on two categories of training, i.e., training on VCCH Module 2016 and training on eVIN. Cold chain handlers were given an initial training to equip them with technical and practical knowledge to efficiently manage vaccines and cold chain system.

CCH Training: Cold chain handlers were made to undergo training on the 'Vaccine and Cold Chain Hander Module (version 2016)' as part of the training process. The VCCH Module training is conducted after every three years. State-wise details are given below in figure13:

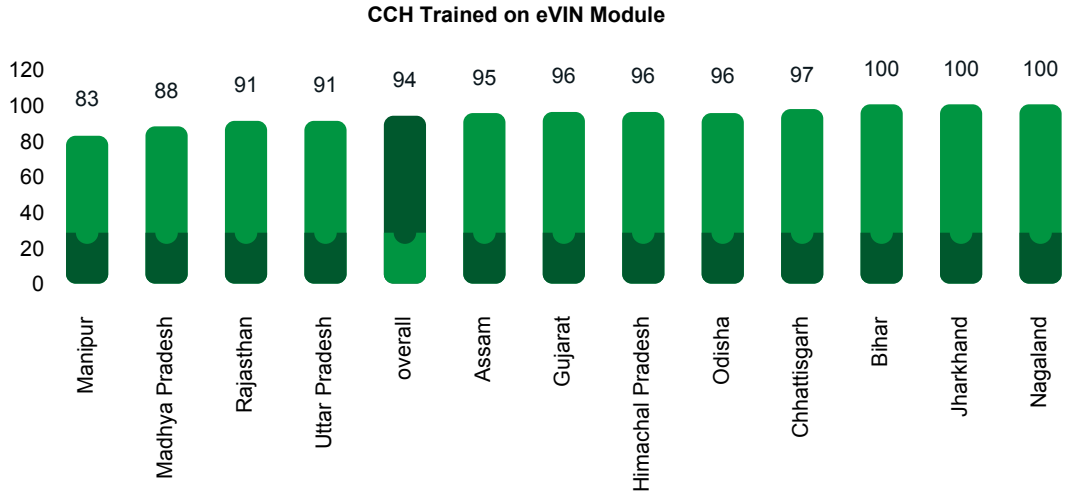
Figure 13: Percentage of CCHs trained on VCCH Module 2016 across eVIN States



- **eVIN states:** Overall, around 90% of CCHs were found to be trained on VCCH Module across eVIN states with maximum number (100%) in Nagaland and Chhattisgarh and least in Manipur (67%). States of Manipur, Himachal Pradesh and Madhya Pradesh have a significant training gap that needs urgent attention.
- **Non-eVIN states:** Around 75% of CCHs were found to be trained on VCCH module in selected non-eVIN states. Capacity building of CCHs for better vaccine and cold chain management is required in these states.

eVIN Training: In Addition to VCCH Module, Implementers Ensured Hands-on Training to CCHs on Using EVIN Technology.

Figure 14: Percentage of CCHs trained on eVIN Module



- Overall, 94% of primary CCHs were trained on eVIN Module and more concerted training efforts are required for states like Manipur, MP and Rajasthan (Figure 14).

Although eVIN training was imparted at the time of roll out of the technology, it is on-the-job training and support of VCCMs that has helped CCHs keep up their performance in maintaining vaccines and cold chain.

Strengthening of Human Resource under eVIN

This section of the report details the measures undertaken by eVIN to empower the state cold chain network. eVIN not only introduced managers at three different levels but also ensured proper training of government cold chain handlers, managers, and staff involved in handling the cold chain system.

State Level

UNDP had appointed State Program Officers (SPO) across eVIN states, responsible for managing operational, technical, and managerial challenges pertaining to eVIN system at the state level.

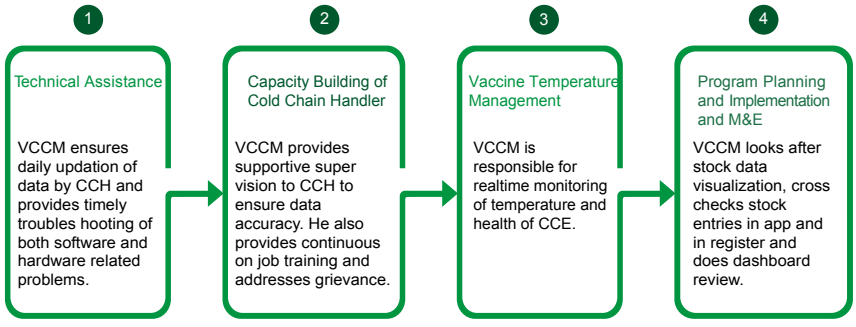
Region Level

UNDP had also appointed a Program Officer at regional level across eVIN states, who are responsible for managing operational, technical, and managerial challenges at the regional level.

District Level

A post for Vaccine Cold Chain and Logistics Manager (VCCM) was added at the district level to provide technical assistance and build the capacities of cold chain handlers, for vaccine temperature management, and program planning and implementation. Major roles and responsibilities of VCCM are depicted in Figure 15.

Figure 15: Roles and Responsibilities of VCCM



Only two states, Rajasthan and Odisha did not have VCCM at the district level at the time of assessment. In rest of the states, 31 districts out of 37 districts had VCCM. The districts having VCCMs were found to be better in documentation and reporting in comparison to the states without. While the state and district officials across all states mentioned that deployment of VCCM as an additional position has made a lot of difference in terms of coordination with CCP, the officials from Rajasthan and Odisha also highlighted the challenges they were facing on withdrawal of VCCM post.

DIOs further added that VCCMs also helped them in making activity plans and prioritizing their visits. Most district respondents mentioned that VCCMs are responsible for monitoring stocks physically and matching the numbers in eVIN app and stock registers. In cases of data discrepancies, VCCMs reported to BMOs, DIOs and POs in their respective states. Majority of data related inconsistencies of stock balancing have been initially recorded because of the errors by CCH in their inability to calculate the stock-outs. VCCMs also act as a point contact in case of any eVIN related issue or problem.

Maximum stakeholders from Jharkhand and Manipur reported that VCCMs played a crucial role in giving on-the-job training and it is interesting to note that in these two states, more than 50% of CCHs are above the age of 50 years.

Take Aways

- *Most of the CCHs are females*
- *Majority of CCHs are above 50 years of age*
- *Only 30% backup CCHs were found across eVIN states. This practice needs universalization*
- *eVIN states are ensuring timely training in comparison to non-eVIN states. They need to gear up*
- *Frequent transfer of CCHs without giving trained substitution across cold chain needs to be avoided*

Voices From the Field

"VCCM provided good support in training and problem solving on the field. After termination of VCCMs from Rajasthan, we are facing problems regarding temperature loggers, training and overall coordination."
District Immunization Officer

"He is accountable for entire vaccine supply chain, at both district and the sub-district levels. He closely monitors vaccine stock levels and temperature range of cold chain equipment. He coordinates with both DVSM and the CCH in terms of vaccine logistics, transportation, and CCE maintenance."
District Immunization Officer

"Some CCHs have been in this role for the last 10-20 years and it was hard for them to change their way of working. Some of them had never even used smartphones. Hence, using eVIN app and entering data required additional efforts from them and it took time for them to learn. In this regard, the eVIN training and VCCM played an important role in building capacity to use the eVIN system. It took time but now all of them can perform whatever is required from them."
District Immunization Officer

3.2 Vaccine Utilization

Procurement of vaccines and cold chain equipment is the responsibility of MoHFW. The projections are made for two years considering the lead-time of procurement. Further, supply orders are placed giving 80% supplies to state stores and 20% cushion at GMSDS. Consequently, supplies are centrally managed by the ministry across 36 States/UTs. This section of the report focuses on the utilization of doses and pipeline stock savings of vaccine doses in pre- and post-period of eVIN implementation at the national level.

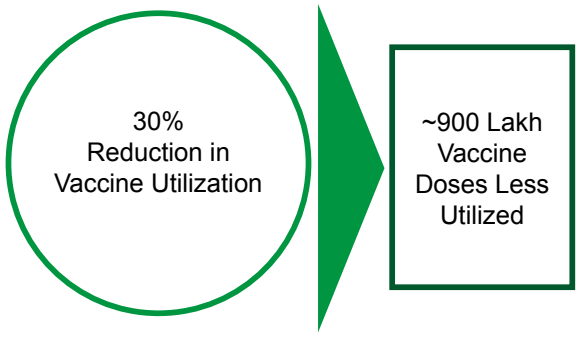
Utilization[m] of Vaccine

Vaccine utilization in doses was computed as:

Vaccine Utilization in lakh doses= (Opening doses+ Doses supplied from GMSD/supplier)-Closing balance

The below figure 16 demonstrates a 30% reduction in utilization of doses. Earlier, 3,053 lakh doses of vaccines were utilized, which has reduced to 2,149 lakh doses after the introduction of eVIN. With the current ongoing RI intensification efforts such as Mission Indradhanush, and Intensified Mission Indradhanush, vaccine utilization should increase over the years. However, 30% lesser utilization has been noticed across eVIN states. The noteworthy reduction in utilization of doses can be attributed to various vaccine supply strengthening measures like eVIN roll-out, implementation of open vial policy, effective vaccine management plans, and other measures taken up to strengthen the health system. eVIN supported manpower of VCCM has also helped in better implementation of open vial policy, capacity building and EVM improvement plan resulting into better vaccine management practices in eVIN states.

Figure 16: Vaccine doses utilized post-eVIN



Vaccine-wise Utilization

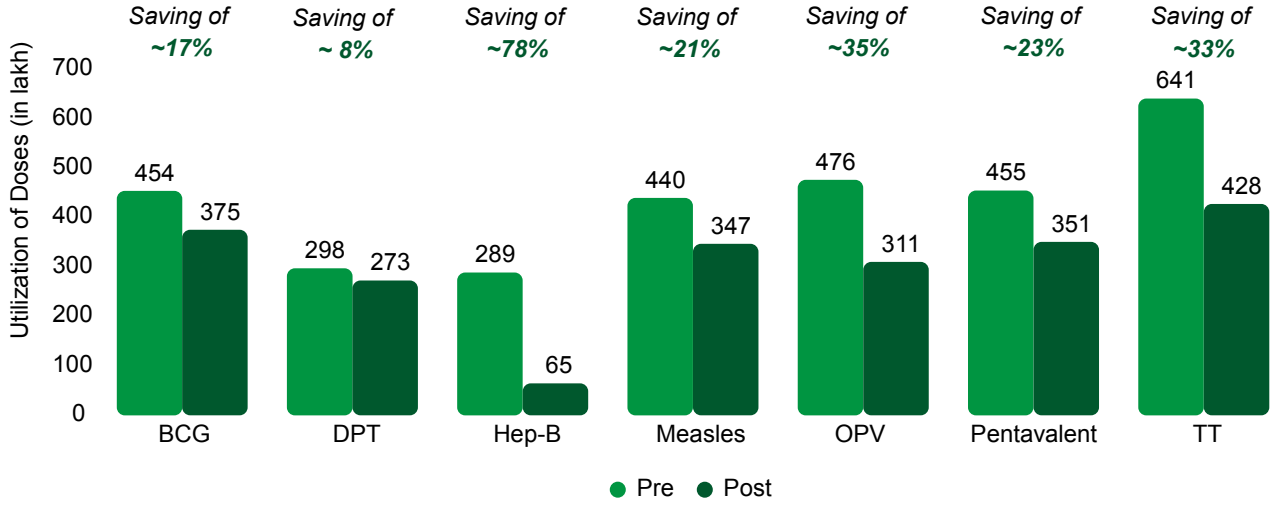
The graph (Figure17) denotes significant saving of all the antigens after implementation of eVIN across 12 states.

- The maximum saving of doses was seen for Hep-B with a decrease by 78%. The reason for the reduction in utilization may be attributed to the limited usage of Hep-B at institutions following the introduction of Pentavalent vaccine.
- In addition, 35% of doses of OPV, 33% doses of TT, 23% doses of Pentavalent and 21% doses of measles vaccines were saved during the post-eVIN period.

[m]Assumptions:
a) The information of vaccine supplies across 12 states was taken from the Immunization Division for three consecutive financial years: 2015-16, 2016-17 and 2017-18.
b) This analysis incorporates data of one year preceding the inception of eVIN and one year after eVIN. As eVIN was implemented in 2015-16 in Madhya Pradesh, Rajasthan and Uttar Pradesh, the duration for the baseline period was different for these three states from the remaining nine states. The endline period for understanding of savings is 2016-17 for these three states and 2017-18 for the remaining nine states.
c) New vaccines like MR, Rota, IPV and PCV were not considered for maintaining uniformity in comparing pre and post intervention impact.
d) Measles vaccine was not considered for Himachal Pradesh because of the introduction of MR in 2016-17.
e) OPV vaccine supply was not considered for Uttar Pradesh, Rajasthan and Madhya Pradesh for both years because of t-OPV to b-OPV switch and mop-up rounds in 2016-17. Considering these factors, vaccine utilization in doses was computed as the sum of opening doses (in lakh) and doses supplied from GMSD or supplier deducting doses of closing balance.
f) This data does not include stock pertaining to campaigns

- It is evident that significant saving reflected across liquid vaccines may be due to the introduction of open vial policy, except in the case of DPT. However, marginal saving was reported in vaccines such as BCG and Measles, which are excluded from the open vial policy.
- DPT has shown the marginal saving of doses, which may be due to the introduction of Pentavalent vaccine replacing DPT at 6, 10 and 14 weeks of age.
- The government has made various efforts to strengthen the immunization supply chain management. With these efforts along with the implementation of eVIN, all states have shown savings of all antigens.

Figure 17: Antigen wise saving in utilization of doses



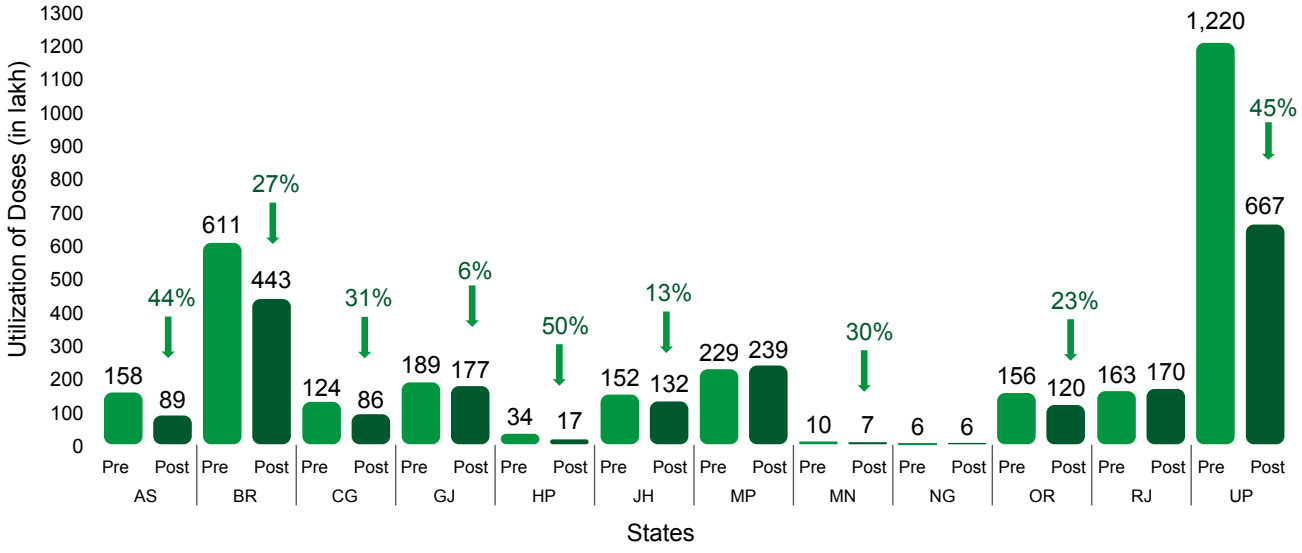
Source: Immunization division, MoHFW

State-wise utilization

Figure 18 indicates the utilization of all vaccines across 12 states after the introduction of eVIN. A total sum of 900 lakh vaccine doses were saved in these states. This is an outcomeof better visibility of state-wise consumption leading to realistic demand reflection of vaccines at the national level. eVIN resulted in real-time visibility of stock helping the health and family welfare ministry to undertake the rational allocation of doses as per the requirement which was not possible earlier.

- Assam, Chhattisgarh, Himachal Pradesh, and Uttar Pradesh have shown more than 30% saving of utilized doses. Other states reported marginal saving of doses.
- However, a marginal increase of 4% has been observed in Madhya Pradesh and Rajasthan due to excessive doses of DPT in post eVIN period.

Figure 18: State-wise savings in vaccine utilization (in lakh doses)



Takeaways

- *30% saving of utilization of doses observed across 12 eVIN states.*
- *Saving of doses is a result of visibility of stock data, reduction in wastage, introduction of open vial policy, continuous capacity building, follow-up on EVM improvement plan resulting in improved vaccine management practices.*
- *There is unanimous reduction in consumption of all antigens, despite of intensified efforts to increase coverage.*

3.3 Stock Management

The goal of vaccine stock management in immunization is basically to estimate the quantum of vaccines required to timely immunize the target population. Good stock management practice requires accurate consideration of the type of vaccine, the presentation (vial size), the quantity and timely delivery of the vaccine. This section includes details on the events of stock-out, minimum stock and maximum or excess stocks to understand whether stock management has improved post implementation of eVIN.

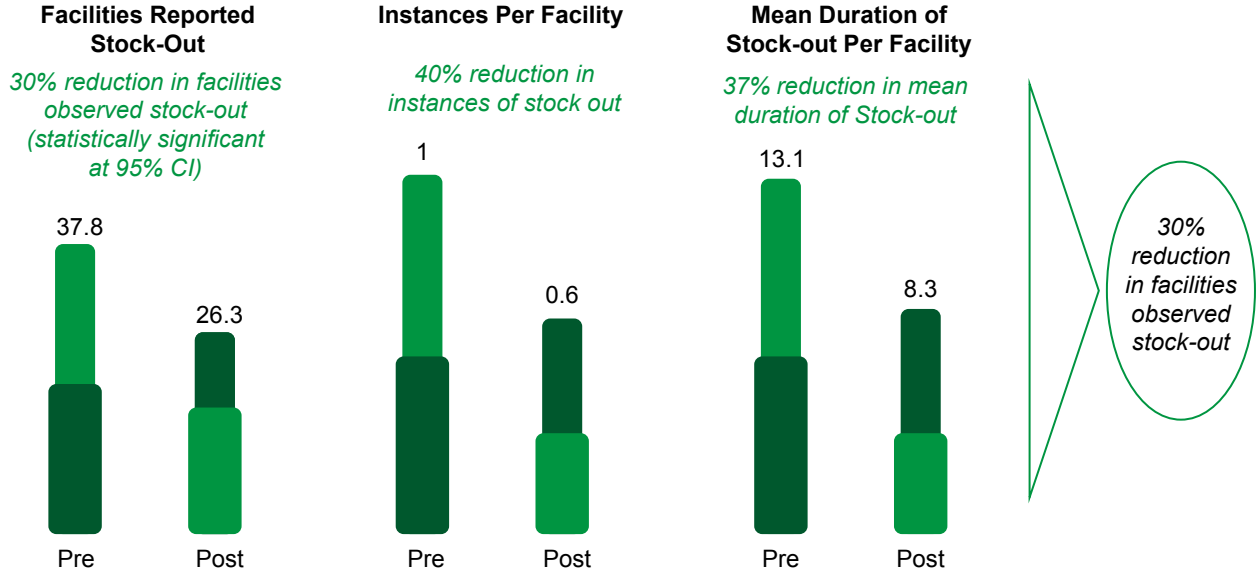
A. Stock-out of Vaccines

This section deals with stock-out situation across sampled facilities of eVIN states .

Snapshot of vaccine stock-out status at Facilities (Figure 19):

- Number of facilities having stock-out of any vaccine showed a remarkable reduction by 30% in post-eVIN period (p<0.001).
- 40% less instances of stock-out per facility was observed after e VIN implementation (p<0.001).
- Average duration of stock-out reduced from 13 to 8 days per facility in an observation period of six months in the post-eVIN period (p<0.001).

Figure 19: Percentage of Facilities Reporting Stock-out of any antigen



*Significance (prtest) * p<0.05, ** p<0.01, *** p<0.001*

**Reference period: Pre: 6 months prior to inception introduction of eVIN , post: Oct'17 to Mar'18, Vaccines-Hep-B, DPT, BCG, Pentavalent, Measles, OPV & TT for 12 states except Measles not included for HP because of MR*

The qualitative findings suggest that the decrease in stock-outs across eVIN states can be attributed to the prompt and timely alerts received by CCHs and managers. Majority of District Officials added that the CCHs are now capable of carrying out the necessary calculations and taking quick actions to reduce stock-out events and duration.

State-wise Percentage of Facilities Reporting Stock-out of any Antigen

The table 12 exhibits general encouraging scenario:

- Out of 12 states, facilities across eight states have shown a decrease in stock-outs in post-eVIN phase; and remarkably not a single instance of stock-out occurred in Chhattisgarh. This may be a consequence of better monitoring and timely review of eVIN dashboards across all levels.
- Out of eight states, five states including Bihar, Chhattisgarh, Gujarat, Rajasthan, and Uttar Pradesh have shown more reduction in stock-out of any vaccine at facility than the overall reduction of 30%. Remaining three states namely Assam, Madhya Pradesh, and Manipur have shown less than 30%.
- On the contrary, after the roll out of eVIN, stock-outs were found to have gone up for the states of Himachal Pradesh, Jharkhand, Nagaland and Odisha, maximum being the state of Jharkhand (400%).
- Though Odisha has shown a slight increase in percentage of facilities reporting stock-outs, a significant reduction of 77% in mean duration of stock-outs and no change in number of instances of stock-outs is noted.
- States like Manipur, Nagaland and Himachal Pradesh are hilly in terrain with smaller vaccines supply.

Table 12: State-wise Percentage of facilities reporting stock-out of any antigen

State	% Facilities			Number of instances/ facility			Days/facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
Assam	56.8	45.5	20	1.0	1.0	0	32.6	14.7	55
Bihar	59.5	35.1	41	2.2	0.7	68	5.3	1.4	74
Chhattisgarh	29.0	0.0	100	0.5	0.0	100	1.4	0.0	100
Gujarat	26.7	7.5	72	0.6	0.1	83	5.8	0.4	93
Himachal Pradesh	65.2	82.6	-27	0.1	1.2	-1100	23.2	34.7	-50
Jharkhand	7.7	38.5	-400	0.1	0.7	-600	0.1	12.5	-12400
Madhya Pradesh	50.0	47.1	6	1.9	1.6	16	26.8	25.9	3
Manipur	100.0	83.3	17	2.2	1.8	18	4.5	12.6	-180
Nagaland	50.0	66.7	-33	1.3	2.5	-92	7.7	51.7	-571
Odisha	23.9	32.4	-36	0.7	0.7	0	34.6	7.9	77
Rajasthan	21.2	6.1	71	0.4	0.1	75	2.9	4.6	-59
Uttar Pradesh	62.1	36.4	41	1.7	0.5	71	6.8	1.8	74
Total	**37.8**	**26.3**	**30**	**1.0**	**0.6**	**40**	**13.1**	**8.7**	**34**

Instances and Days of Stock-out

- The analysis shows a downward trend of the instances of stock-outs/facility post roll-out of eVIN except for Himachal Pradesh, Jharkhand, and Nagaland.
- Overall there is a 40% reduction in instances of stock-out, from one instance per cold chain point (for six months observation period) in pre-eVIN to 0.6 instances per cold chain point in post-eVIN.
- Maximum reduction was observed in Chhattisgarh with no instance in post-eVIN period
- In post-eVIN period, mean days of stock-outs/facility increased in Himachal Pradesh, Jharkhand, Manipur, Nagaland and Rajasthan. Highest increase is reported in Jharkhand.

Vaccine-wise Analysis of Stock-outs[n]

- Vaccine-wise analysis for stock-outs, as shown in table 13, show that all vaccines observed a remarkable reduction in stock-out at facilities across eVIN states.
- Percentage change in facilities reporting stock-out has substantially reduced for all except DPT vaccine (60% for OPV, 57% for TT, 56% for Hep-B and 48% for Measles vaccine).
- Maximum reduction in facilities reporting stock-out was observed for OPV while DPT showed minimum reduction.
- Number of stock out instances per facility has reduced for all vaccine except DPT which shows 6% increase in number of stock out instances/facility.
- Further, deeper analysis of vaccine-wise instances of stock-outs at facilities depicts that after eVIN rollout, instances of zero stock at facilities is mainly due to OPV (64%), Hep-B (64%), Measles (53%), followed by TT (50%) and BCG (33%).
- After implementation of eVIN, mean duration of stock-out/facility increased for DPT vaccine only. Maximum reduction in number of days of stock-out/facility was observed for Measles (72%), followed by Hep-B (65%) and Pentavalent (62%).

Table 13: Facilities Reporting Stock-out of any antigen

Vaccine	% Facilities			Number of instances/facility			Days/facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
BCG	10.0	7.3	27	0.12	0.08	33	1.5	0.9	40
DPT	14.4	13.3	8	0.16	0.17	-6	2.3	3.1	-35
HEP-B	10.7	4.7	56	0.11	0.04	64	2.3	0.8	65
Measles	14.9	7.8	48	0.19	0.09	53	2.5	0.7	72
OPV	16.9	6.8	60	0.22	0.08	64	2.1	1.1	48
PENTA	8.3	4.9	41	0.10	0.06	40	1.3	0.5	62
TT	6.5	2.8	57	0.08	0.04	50	0.4	0.2	50

Voices From the Field

"Events of stock outs have considerably gone down and in fact reduced to 0.1% only due to eVIN. Rare stock outs which happen are also because of the 67 nonfunctional Cold Chain Points. eVIN has helped CCTs become more informed, vigil and prompt. It has really brought in transparency into the system."
State Officer

"Now stock out are less and we have been able to use open vials across the states. My state has been appreciated for no stock out for 14 days in a row."
State Immunization Officer

B. Minimum stock of vaccines

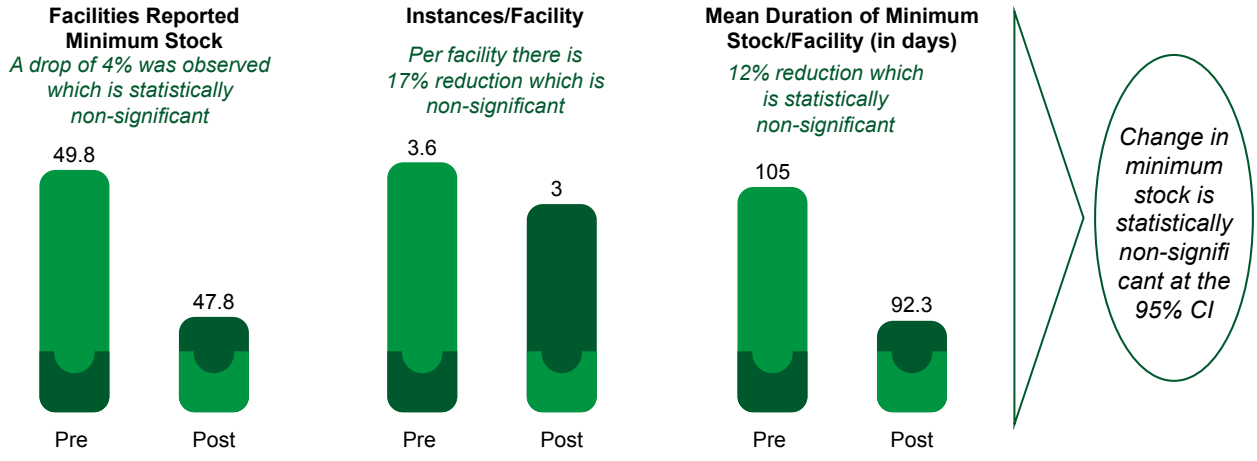
The minimum stock level of vaccines is the level below which the stock should never drop without having placed an order. This is also known as "reorder level". This is usually expressed as the numbers of weeks/months of requirement. This section talks about practices of maintaining minimum stock level.

Snapshot of Minimum Stock

It is important to ensure that the cold chain system is not over-burdened as well as are not under supplied.

[n]Vaccines-Hep-B, DPT, BCG, Pentavalent, Measles, OPV & TT for 12 states except Measles not included for HP because of introduction of MR
Secondary data from UNDP was analyzed for Bihar and Manipur due to under-reporting of data during the visits.

Figure 20: Percentage of Facilities observing Minimum stock of any antigen



*Significance (prtest) * p<0.05, ** p<0.01, *** p<0.001, p value: 0.320*

**Reference period: Pre-eVIN: 6 months prior to inception of eVIN , Post-eVIN: Oct'17 to Mar'18, Vaccines-Hep-B, DPT, BCG, Pentavalent, Measles, OPV & TT for 12 states except Measles not included for HP because of introduction of MR*

- As shown in Figure 20, there is a 4% drop in percentage of facilities reporting minimum stock of any vaccine after implementation of eVIN (p>0.1).
- A marginal reduction in instances of minimum stock per facility is observed where the decline is from 3.6 instances in the pre-eVIN period to three in the post-eVIN period (p>0.1).
- The average duration of minimum stock per facility has reduced from 105 days to 92 days after the implementation of the eVIN system (p>0.1).

State-wise Variation in Instances and Duration of Minimum Stock of any Antigen

- As depicted in Table 14, the percentage of facilities observing minimum stocks of any vaccine declined in Assam, Bihar, Chhattisgarh, Madhya Pradesh, Rajasthan, and Uttar Pradesh. However, more facilities observed minimum stock in Himachal Pradesh, Jharkhand, Nagaland, and Odisha. There was no change in minimum stock status in Gujarat and Manipur.
- Number of instances of minimum stock per facility improved for Bihar, Chhattisgarh, Gujarat, Madhya Pradesh, Rajasthan and Uttar Pradesh. Highest percentage increase in number of instances of minimum stock was reported in Jharkhand, Odisha and Nagaland.
- Days of minimum stock per facility has improved in Bihar, Chhattisgarh, Gujarat, HP, Manipur, Rajasthan, and UP. The average number of days of minimum stock/facility increased in Assam, Jharkhand, MP, Nagaland and Odisha. Nagaland has the highest number of days of minimum stock followed by Assam.

Table 14: Facilities observing Minimum stock of any antigen by state

State	% Facilities observed minimum stock of any vaccine			Number of instances of minimum stock/facility			Days of minimum stock/ facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
Assam	13.6	11.4	16	0.3	0.3	0	1.8	5.1	-183
Bihar	91.9	91.1	1	19.2	12.6	34	172.3	102.7	40
Chhattisgarh	41.9	19.4	54	0.9	0.3	67	2.5	0.6	76
Gujarat	20	20	0	0.6	0.5	17	14.7	10.6	28

State	% Facilities observed minimum stock of any vaccine			Number of instances of minimum stock/facility			Days of minimum stock/ facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
Himachal Pradesh	82.6	87	05	4	4.1	02	560.5	513.5	8
Jharkhand	23.1	46.2	-100	0.2	1.2	-500	14.4	17.3	-20
Madhya Pradesh	83.8	80.9	3	6.2	5.5	11	97.1	101.3	-4
Manipur	100	100	0	27.7	32.3	-17	243.3	192.8	21
Nagaland	33.3	100	-200	1.7	4.2	-147	15.8	215.2	-1262
Odisha	39.4	42.3	-7	0.4	2	-400	64.6	83.9	-30
Rajasthan	40.9	32.6	20	1.8	1.2	33	100.5	62.4	38
Uttar Pradesh	92.4	90.9	2	5.3	4.7	11	267.3	242.6	9
Total	**49.8**	**47.8**	**4**	**3.6**	**3**	**17**	**105.4**	**92.3**	**12**

Vaccine-wise Instances and Duration of Minimum Stock (Table 15)

- The percentage of facilities reporting minimum stock of vaccine was more in the case of DPT and Pentavalent compared to any other vaccines. The percentage of facilities showing minimum stock of DPT had increased from 32.9% in pre-eVIN to 34.5% in post-eVIN phase.
- The vaccine-wise instances of minimum stocks at facilities also revealed that among the seven vaccines, the reduction in number of instances of minimum stock among facilities was observed for TT followed by Measles, OPV, Hep-B, Penta and BCG. DPT had 21% increase in number of instances of minimum stock.
- Days of minimum stock per facility is highest for DPT. Number of days of minimum stock/facility had increased from 9.3 days in pre-eVIN to 17.5 days post-eVIN for DPT. The number of days of minimum stock of Pentavalent has reduced by 42%.

Table 15: Facilities reporting Minimum Stock in Pre- eVIN and Post- eVIN period by antigen

Vaccine	%Facilities			Number of instances/total sample facilities			Days/Sampled facilities		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
BCG	33.4	29.8	11	0.53	0.5	6	15.6	13.2	15
DPT	32.9	34.5	-5	0.47	0.57	-21	9.3	17.5	-88
HEP-B	19.9	15.9	20	0.21	0.19	10	10.7	10.3	4
Measles	31.9	27.2	15	0.78	0.58	26	15.3	12.1	21
OPV	36.3	31.4	13	0.7	0.55	21	19.3	16.1	17
PENTA	24.6	26.4	-7	0.46	0.42	9	18.6	10.7	42
TT	29.8	17.3	42	0.47	0.2	57	11.5	9.5	17

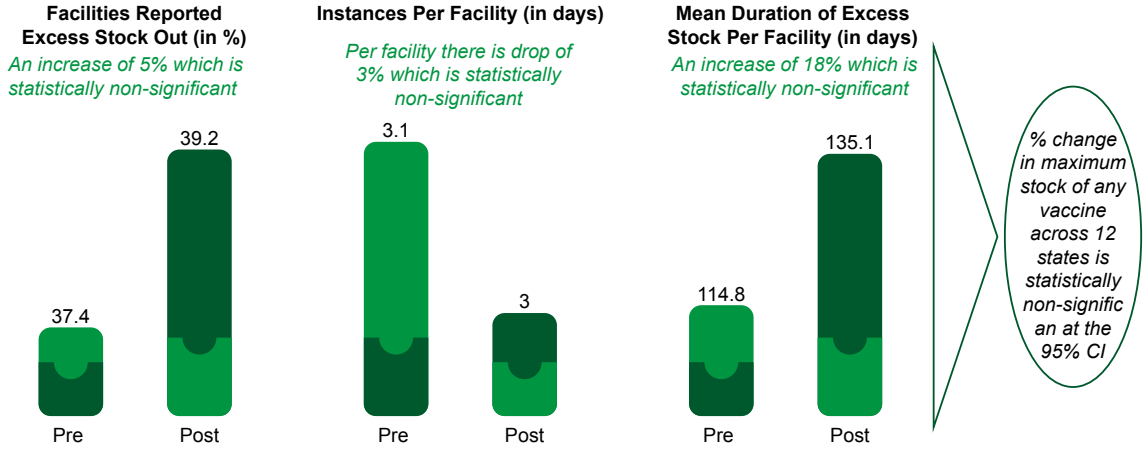
C. Maximum Stock of Vaccines

Maximum stock is defined as the minimum stock plus the amount of stock used between orders i.e., working stock. The maximum level was set to guard against the excess stock, which may result in losing vaccines to expiry before use.

Snapshot of Maximum Stock (Figure 21)

- Contrary to the expectation, ~2 percentage point increase had taken place in facilities reporting instances of maximum stock (p>0.1).
- Instances of maximum stock per facility had marginally declined by 3% after eVIN implementation. Hence, very few CCHs were avoiding maximum stock at their CCPs (p>0.1).
- Further, while the average no of day's maximum stock would last was for 115 days prior to eVIN, findings show that it now lasts for about135 days. Earlier, CCHs were not aware about the concept of maximum stock, eVIN system has introduced the concept and made it visible across all levels (p>0.1).

Figure 21: Percentage of Facilities Observing maximum stock of any antigen



*Significance(prtest) * p<0.05, ** p<0.01, *** p<0.001*

**Reference period: Pre: 6 months prior to inception of eVIN , post: Oct'17 to Mar'18, Vaccines-Hep-B, DPT, BCG, Pentavalent, Measles, OPV & TT for 12 states except Measles not included for HP because of introduction of MR*

State-wise variation in Instances and Duration of Excess Stock of any Antigen

Table 16 shows maximum stock of any antigen per facility across 12 states during pre- and post-eVIN roll-out.

- Pre- and post-eVIN comparison showed an overall 5% increase in maximum stock at facilities. This may be attributed to the increased visibility across all levels of supply chain post eVIN implementation.
- No change is seen in the percentage of facilities observing maximum stock of any vaccine especially in Assam, Chhattisgarh and Jharkhand.
- Most of the facilities in Bihar, Gujarat, HP, Nagaland, Odisha, Rajasthan and UP showed an increased maximum stock situation in post-eVIN phase.
- The maximum stocks were observed in facilities of Nagaland state, almost twice the excess stocks in post-eVIN phase.

Table 16: Facilities observing Maximum stock of any antigen by state

State	% Facilities observed maximum stock of any vaccine			Number of instances of maximum stock/facility			Days of maximum stock/facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
Assam	2.3	2.3	0	0	0	0	0.02	0.2	-900
Bihar	9.19	94.6	-3	16.1	14.5	10	233.9	402.5	-72
Chhattisgarh	3.2	3.2	0	0	0	0	0.1	0.1	0

State	% Facilities observed maximum stock of any vaccine			Number of instances of maximum stock/facility			Days of maximum stock/facility		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
Gujarat	9.2	10	-9	0.4	0.3	25	26.4	24.2	8
Himachal Pradesh	52.2	56.5	-8	0.2	3.2	-1500	140.5	225.6	-61
Jharkhand	38.5	38.5	0	0.8	0.8	0	52.8	124.1	-135
Madhya Pradesh	91.2	88.2	3	8.8	8.6	2	508.7	409.1	20
Manipur	100	83.3	17	20.5	11.3	45	111.8	32.6	71
Nagaland	16.7	66.7	-299	0.2	3	-1400	61.5	65.8	-7
Odisha	36.6	42.3	-16	1.6	0.8	50	70.4	109.8	-56
Rajasthan	31.1	32.6	-5	1.6	1.7	-6	54.5	92.6	-70
Uttar Pradesh	47	50	-6	1.9	1.8	5	110.1	155.3	-41
Total	**37.4**	**39.2**	**-5**	**3.1**	**3**	**3**	**114.8**	**135.1**	**-18**

- Though the events of maximum stocks have increased, substantial reduction in number of instances per facility for all states except Himachal Pradesh, Nagaland and Rajasthan was observed.
- Maximum stock was observed for more number of days/facility across all states except MP and Manipur.

Vaccine-wise Variation in Instances of Maximum Stock

- As exhibited in table 17, the percentage of facilities observing maximum stock had increased for TT, Pentavalent, OPV, Measles and BCG, while a decrease is noted for Hep-B and DPT despite the implementation of eVIN.
- Number of instances of maximum stock/facility had increased for measles, OPV, Pentavalent and TT.
- Number of days of maximum stock/facility had increased for BCG, OPV, Pentavalent and TT, whereas it had decreased for measles.
- Improvement had been seen in instances of excess stock for DPT and Hep-B vaccines in post-eVIN-phase. The reduction in events of excess stock of DPT and Hep-B may be attributed to the introduction of pentavalent vaccine.

Table 17: Facility observed antigen wise instances of Excess Stock in Pre- eVIN and Post- eVIN period

Vaccine	%Facilities			Number of instances/total sample facilities			Days/Sampled facilities		
	Pre	Post	% Reduction	Pre	Post	% Reduction	Pre	Post	% Reduction
BCG	25.1	25.8	-3	0.61	0.61	0	18.9	20.3	-7
DPT	28.2	21.6	23	0.5	0.32	36	21.1	12.9	39
HEP-B	23.7	17.2	27	0.35	0.27	23	13.1	12.3	6
Measles	21.4	23	-07	0.35	0.4	-14	22	16.1	27
OPV	26.7	30.3	-13	0.52	0.55	-6	17.2	22.5	-31
PENTA	21.4	27.2	-27	0.4	0.44	-10	10.5	19.2	-83
TT	20.1	27.7	-38	0.32	0.38	-19	14.8	25	-69

- More efforts are required to reduce the number of maximum and minimum stocks. Key informants revealed that stock maintenance at normal level was a challenge in pre-eVIN time and this challenge still continues.

D. Missed Opportunity

Efficient and effective immunization supply chain management will ensure that a single child will not miss his/her vaccination due to logistical problems such as shortage of vaccines[11]. Eliminating missed opportunities will have the potential to raise immunization coverage in a population, particularly when the availability and use of health services is high. This section focuses on change in missed opportunity due to vaccine shortage in pre- and post-eVIN implementation phase.

Table 18 shows antigen-wise, sessions missed due to stock-out, and subsequent missed opportunities. Implementation of eVIN showed substantial decrease in events of missed sessions for all vaccines except for BCG and DPT. However, the stock-out of DPT in post-eVIN had starkly increased by 82%. This can be attributed to the fact that DPT had been limited to booster doses only and also to the introduction of Pentavalent vaccine. These numbers were corroborated with the lesser number of sessions missed due to stock-out of Pentavalent in post-eVIN phase. The subsequent number of missed opportunities for all antigens had reduced after post-eVIN implementation, however, the reduction in missed opportunity due to BCG and Hep-B was found to be marginal. Though the number of missed sessions increased for BCG in post-eVIN, the number of missed opportunities increased due to differential coverage in pre- and post- eVIN phases. A similar pattern was visible for Hep-B as well.

- The highest reduction of 70% in events of missed opportunities was observed for Pentavalent ($p<0.001$).
- Reduction in events of missed opportunity due to BCG and Hep-B was found to be minimum.

Table 18: Antigen wise sessions missed due to stock-out and resulting missed opportunities

Antigen	Session Missed		%Reduction in session missed	Missed Opportunity		%Reduction in missed opportunity
	Pre-eVIN	Post -eVIN		Pre-eVIN	Post- eVIN	
BCG	1076	1110	-3.2	2096	1961	6.4
HEP-B	2562	2034	20.6	1837	1833	0.2
OPV	1666	995	40.3	13954	8159	41.5
DPT	1964	3582	-82.4	7382	5902	20.0
Penta	2013	386	80.8	7093	2109	70.3
Measles	1790	1112	37.9	5969	3467	41.9
TT	674	536	20.5	3729	2593	30.5

Significant reduction in instances of missed opportunities for all antigens

Table 18 shows, stark reduction in instances of missed opportunity i.e. an event where in a child could not be immunized due to stock-out and non- availability of the vaccine. This shows a strong reflection of the value add and positive impact of eVIN implementation has had on the immunization coverage in the country.

Takeaways

- *Nagaland, Jharkhand, Odisha, and Himachal Pradesh have reported increased events of stock outs and minimum stock events. Rigorous monitoring and capacity building is required for better vaccine stock management.*
- *Maximum stock management has not shown any significant improvement across eVIN states. The concept needs to be reinforced because stacking at facility level is not advisable and it may lead to wastage of vaccines.*
- *With significant reduction in stock-outs, events of missed opportunity for immunization had decreased, especially for pentavalent up to 70%.*

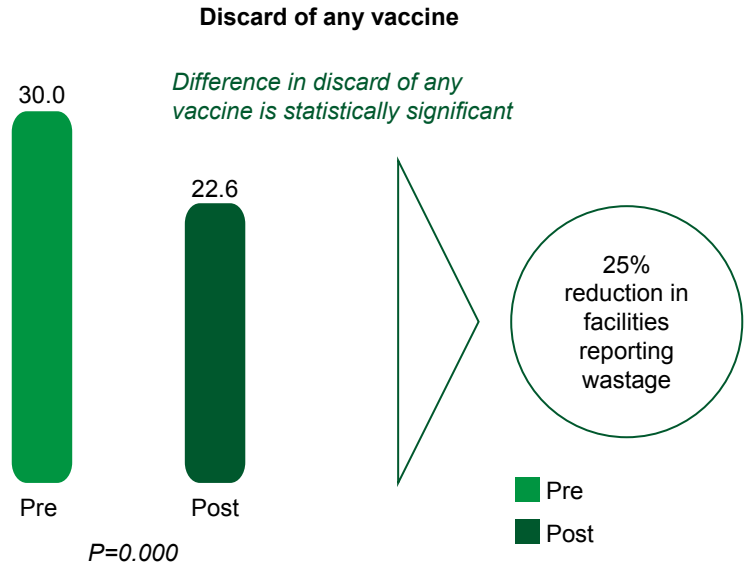
3.4 Vaccine Wastage

Vaccine wastage is categorized primarily into two types: a) wastage of the remaining doses in opened vials at the end of an immunization session, and b) wastage from unopened vials generally due to problems related to the cold chain, breakage or expiry[12]. World Health Organization reports over 50% vaccine wastage around the world. Over-ordering of vaccines is the leading problem in the distribution chain and causes majority of wastage[13]. In India, prior to 2013 open vial policy (OVP), all vaccine vials opened for an immunization session were discarded at the end of that session, irrespective of the type of vaccine or the number of doses remaining in the vial. OVP reduced both vaccine wastage as well as governmental healthcare costs for immunization[14].

In a country like India, it is important to understand magnitude of the vaccine wastage[o] and minimize avoidable causes of loss of vaccine through corrective measures and actions. But at the same time, there is paucity of evidence in primary health care settings where vaccine wastage may be higher due to electricity failure, lack of trained man power and remote outreach sessions conducted frequently[15]. This section focuses on avoidable wastage from unopened vials (data source: UNDP reported eVIN and VCCM records).

- A comparative analysis of pre-eVIN and post-eVIN data for discarding of vaccines showed a 25% reduction in facilities reporting wastage. This reduction in wastage across facilities was statistically significant ($p<0.001$) (Figure 22).

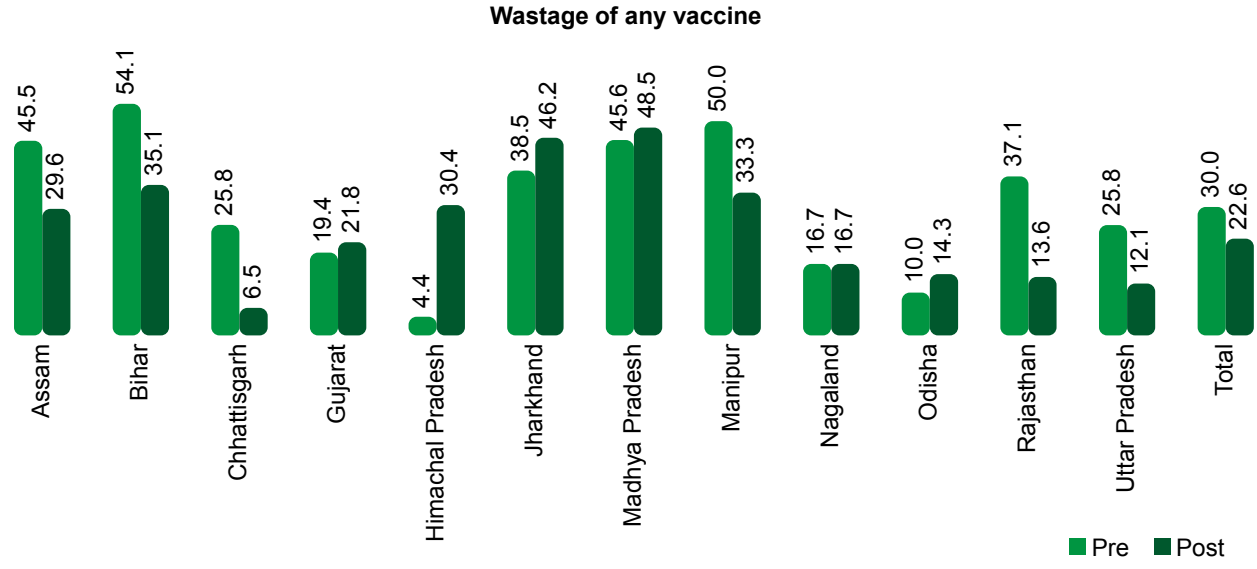
Figure 22: Percentage of Facilities reporting vaccine wastage in Pre-eVIN and Post-eVIN phase



Furthermore, state-wise variation in percentage of facilities reporting vaccine wastage (of unopened vials) depicted in Figure 23 showed that Gujarat, Jharkhand, Madhya Pradesh, Odisha, and Himachal Pradesh observed increased discarding of doses after implementation of eVIN. The increase in vaccine wastage in these states are statistically non-significant ($p>0.1$). However, remaining states have observed reduction in vaccine wastage which was statistically significant. ($p<0.001$). This increase in vaccine wastage strongly indicate implementation and/or capacity gap and calls for attention to understand the related reasons of wastage across eVIN states. The remaining six states had experienced significant reduction in events of wastage of any vaccine.

[o]UNDP data has been considered for information on vaccine wastage as field recordings were not available for most of the states.

Figure 23: Percentage of facilities in the state having any discard of vaccine



Gujarat, Jharkhand, Odisha, Madhya Pradesh and Himachal Pradesh: observed increased discard of doses

Doses Discarded

Further, discussion about the percent change in antigen wise wastage of doses, has gone down for all the vaccines in post-eVIN period. Reduction in quantum of wastage for BCG, DPT, Measles, and TT vaccine after eVIN implementation was particularly remarkable. Minimum reduction of 22% was observed for OPV (Table 19).

Table 19: Antigen wise doses of vaccines discarded in Pre-eVIN versus Post-eVIN period

State	Pre-eVIN	Post-eVIN	%Reduction in doses discarded
BCG	3850	770	80.0
DPT	23972	319	98.7
HEP-B	1920	1000	47.9
MEASLES	1025	200	80.5
OPV	5760	4500	21.9
PENTA	870	490	43.7
TT	1110	200	82.0

Qualitative Findings

In sync with the data obtained, majority of the state and district officials mentioned having control on vaccine wastage after eVIN introduction. The analysis revealed that reduced vaccine wastage was quoted as second biggest advantage of the system followed by reduction in stock-outs. They further added the reduction was because of decreased incidents of freezing, use of open vial policy, judicious indenting, and batch management at district level etc.

While 11 states acknowledged various factors contributing to vaccine wastage reduction, officials from Himachal Pradesh mentioned that eVIN could not help much in decreasing wastage. On probing, it was further found that data loggers in the state were either non-functional and or not installed at all. It can be assumed that functional system with working equipment could be a major reason for better vaccine management and subsequent reduction in wastage.

Voices From the Field

"Although eVIN has brought about good changes in the system like auto indenting and providing digital stock information, but I cannot do much in reducing vaccine wastage because data loggers do not work. I do whatever I can manually, but it is always prone to errors."

District Immunization Officer

Takeaways

- *Facilities reporting avoidable wastage/discard of vaccine have reduced to 25% across eVIN states*
- *DPT, BCG, Measles, and TT vaccines have shown more than 80% saving across facilities in eVIN states.*
- *Poor documentation of wastage data was observed across all cold chain points.*

3.5 Vaccine Distribution

India has four national vaccine stores called Government Medical Supply Depots (GMSDs), which receive, store, and supply huge quantity of vaccines, cold chain equipment and support logistics across the country. Vaccines are then transported to state vaccine stores; and through regional and district vaccine stores it reaches the last cold chain point (CHC or PHC).

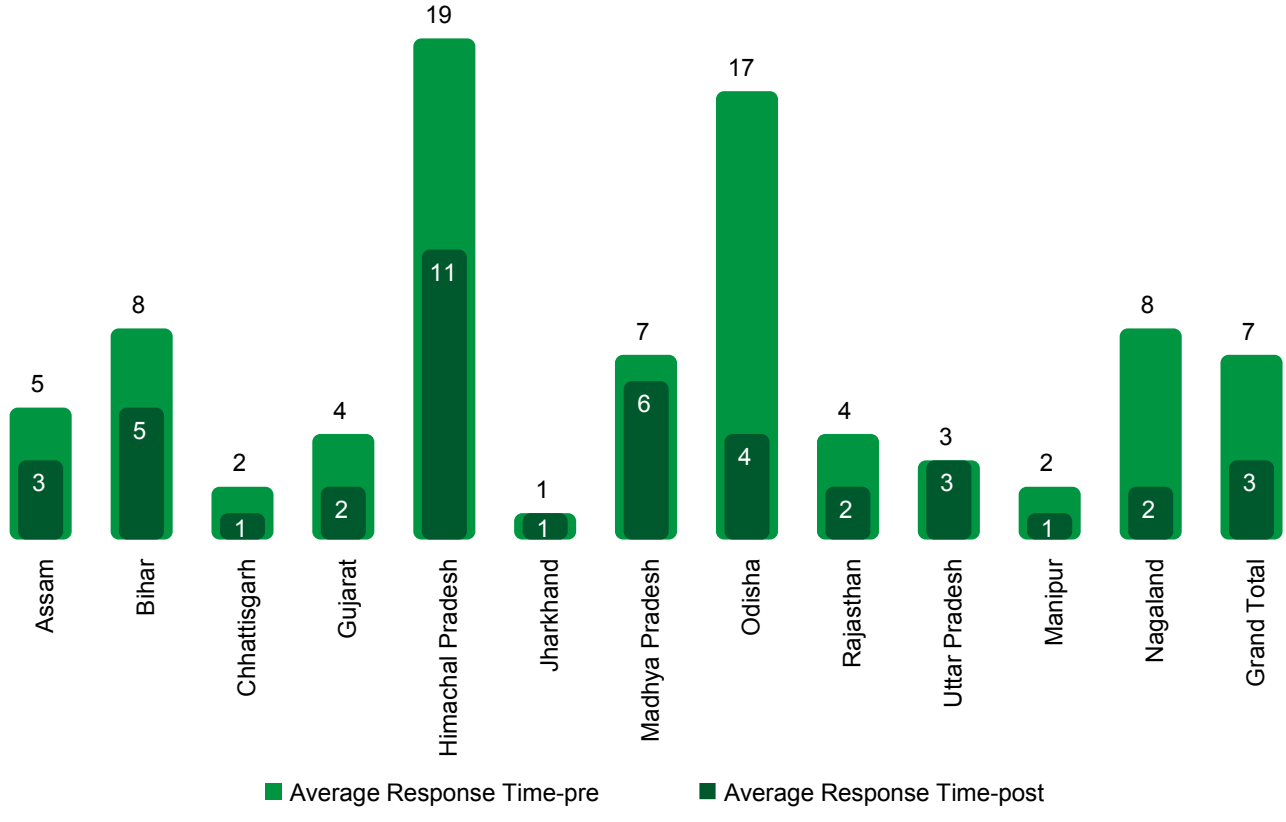
In India, supply chain equilibrium of vaccines is maintained through push and pull mechanism and stock oscillates between one to three months. This section highlights the vaccine distribution across the states.

Replenishment Time

In this assessment, an attempt has been made to assess the impact of eVIN on mean replenishment time and change in replenishment time between supply and indenting of vaccines across cold chain facilities. Replenishment time was calculated as the difference between the date of supply received and date of indent raised to higher store as shown in Figure 24.

- Mean replenishment time between supply and indent had reduced by 57% across the facilities in 12 states. Overall reduction in replenishment time across facilities was statistically significant ($p<0.001$).
- The time between indent and supply of vaccines had decreased for all the states except Jharkhand.
- Four states namely, Chhattisgarh, Gujarat, Rajasthan, and Manipur could successfully reduce the replenishment time to half in the post-eVIN compared to the pre-eVIN period. The contributing factor attributable was better vaccine management practices and quick response actions to demands on account of continuous monitoring at district level.

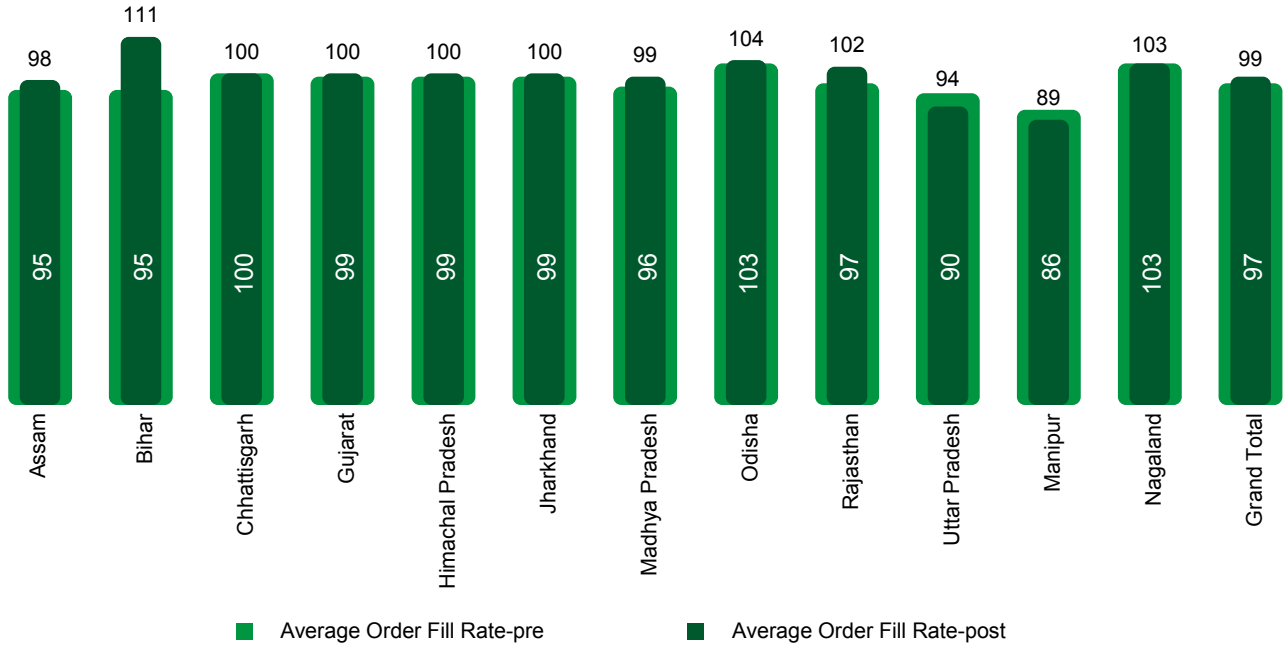
Figure 24: Vaccine indent replenishment time (in days)



Order Fill Rate

As a metric of inventory management, fill rate is technically defined as proportion of quantity received to quantity indented. This is basically a measure of percentage of demands that were met at the time the order was placed. It is observed that overall there was a marginal increase of 2% in order fill rate from pre- to post-eVIN phase. The marginal increase in order fill rate was statistically non-significant at 95% confidence interval (Figure 25).

Figure 25: Order Fill Rate in Percentage



At first glance, it seemed that efficiency in meeting demand had increased to 3% for Madhya Pradesh and Assam between pre- and post-implementation phase of eVIN.

But, order fill rate is considered as not being a true reflection of the improvement in efficiency in vaccine distribution because of instances recorded of excess distribution by the states in comparison to the actual demand at the facilities.

The practice of better utilization of eVIN dashboard as an evidence-based decision-making tool for stock management and vaccine distribution can aid in resolving such situations in the interim and long run. The present eVIN system does not emphasize on order management and is strongly recommended for inclusion for improved vaccine management practices.

Expiry Days Left

As a good stock management practice, it is important the batches of vaccines closest to expiry are sent out and distributed first by the managing stores. This ensures minimal wastage of vaccines and also ensures that vaccines are utilized within their shelf life.

Data pertaining to adherence of FEFO (First expiry First out) practices at the level of cold chain facilities and at the level of district vaccine stores was captured in the assessment.

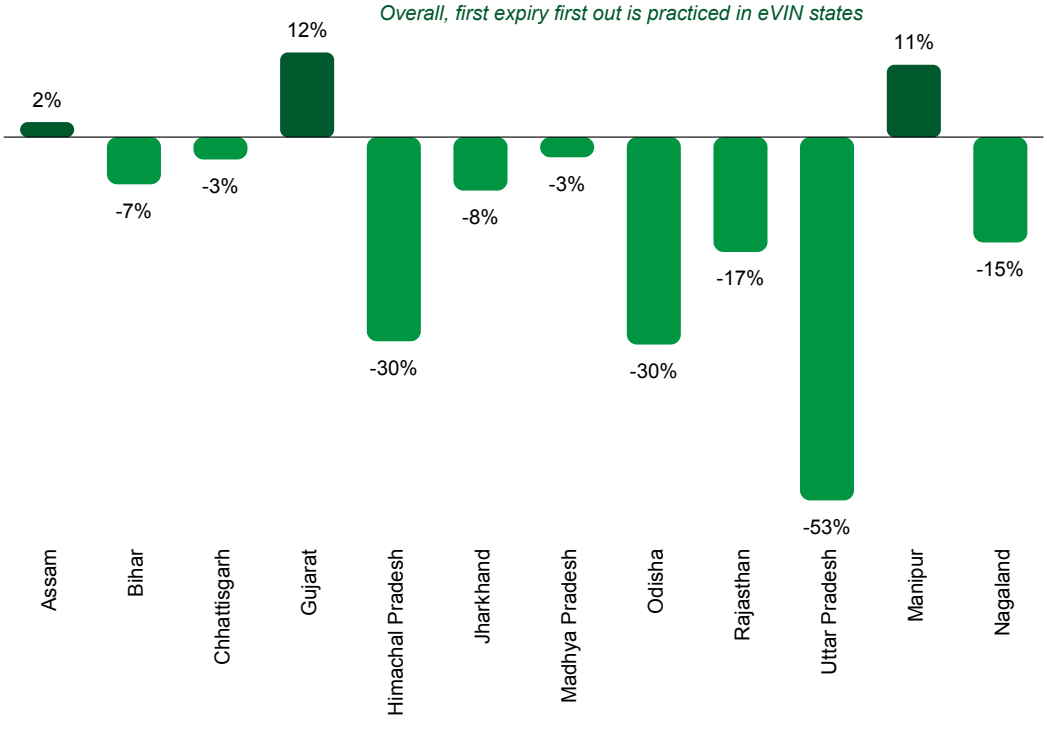
As shown in table 20, data pertaining to number of days left in expiry of the vaccine at the level of cold chain points indicated an overall improvement of 10% in management of vaccines. Among the 12 states, Uttar Pradesh showed

two-fold increase in managing expiry days post-eVIN intervention (Figure 26). Moreover, challenging geographical areas like Himachal Pradesh also showed significant increase of 30% in reduction of the expiry days left for the vaccines. Odisha demonstrated a gross reduction of nearly half a month in the mean expiry days left for the vaccines. Across all levels of supply chain, adherence to FEFO was observed.

Table 20: Expiry days left at Cold Chain Point

State	Pre-eVIN	Post-eVIN	% Reduction
	Mean expiry days	Mean expiry days	
Assam	408	417	-2
Bihar	522	486	7
Chhattisgarh	466	451	3
Gujarat	473	532	-12
Himachal Pradesh	187	131	30
Jharkhand	486	448	8
Madhya Pradesh	480	466	3
Odisha	493	343	30
Rajasthan	487	405	17
Uttar Pradesh	538	251	53
Manipur	348	385	-11
Nagaland	343	290	15
Grand Total	**428**	**384**	**10**

Figure 26: Percentage Change in Number of days left in expiry of vaccines at Cold Chain Points



CCP to CCP sharing of vaccine

As a normal practice at the operational level, facilities tend to share vaccines and other resources in the case of shortage. This assessment made an attempt at capturing such instances of sharing of vaccines from CCP to CCP. It was observed that post-eVIN CCP to CCP sharing process was further streamlined, leading to a reduction by 12% in availability of vaccines across the states.

Table 21: Lateral Sharing of vaccines from CCP to CCPs

State Name	Number of instances		Number of doses	
	Pre-eVIN	Post-eVIN	Pre-eVIN	Post-eVIN
Assam	11	1	3140	100
Bihar	0	0	0	0
Chhattisgarh	38	11	3080	460
Gujarat	29	2	3620	60
Himachal Pradesh	0	2	0	20
Jharkhand	1	2	100	250
Madhya Pradesh	520	490	294988	119625
Manipur	0	0	0	0
Nagaland	0	0	0	0
Odisha	203	272	76630	190959
Rajasthan	399	317	117667	124987
Uttar Pradesh	12	16	3304	3747
Grand Total	**1213**	**1113**	**502529**	**440208**

It is evident from table 21 that CCHs of Bihar, Manipur and Nagaland do not share vaccines from CCP to CCP in both pre- and post-eVIN period. Further, states such as Assam, Chhattisgarh, and Madhya Pradesh have also shown reduction in the number of dosages shared across CCPs post-eVIN that signifies that states are better enabled in vaccine stock management. Following operationalization of order management tool in the eVIN system, it is expected that CCP to CCP sharing of vaccines will reduce further or completely stop the practice.

Qualitative Findings

There is not much difference in the responses of the key informants from the field to the findings of the data; and efficient vaccine distribution is the attributing factor as one of the best practices of eVIN implementation. The reasons reported for reduction in wastage was the use of FEFO rule, the known reasons of vaccine wastage viz. a viz. vial breakage, unreadable label, wastage due to freezing etc. to cite a few among others. Informants further added that this information helped them take necessary actions to ensure delivery of potent vaccines to the community within stipulated time and expiry date.

Voices From the Field

"One month ago, SVS gave 8000 doses of Hep-B vaccines with due expiry in one month. Our consumption is only 1000 dose at district level and it was not possible for us to consume whole lot of vaccine in that month. With eVIN, population needs are known, and I could manage to distribute all vaccines in due time and thus a lot of vaccines were prevented from getting waste."

District Immunization Officer

3.6 Stock Management Practices

Stock management practices of pre- and post-eVIN periods were compared and the impact of eVIN was assessed across the 12 states. This section emphasizes on the record keeping practices of CCHs and frequency of updating of records at CCPs followed in the facilities.

Record Keeping Practices

Overall, findings as shown in tables 22 and 23 show an improvement in record keeping practices in the facilities across the states.

Table 22: Percentage of facilities with proper record keeping practices in pre-eVIN

State	pre-eVIN					
	GoI register	Loose papers	MIS	No stock available	Other than GoI register	Others
Assam	56.8	25.0	2.3	0.0	15.9	0.0
Bihar	51.4	0.0	0.0	0.0	48.7	0.0
Chhattisgarh	0.0	77.4	3.2	0.0	19.4	0.0
Gujarat	55.8	0.8	0.0	0.8	41.7	0.8
Himachal Pradesh	34.8	8.7	0.0	0.0	56.5	0.0
Jharkhand	7.7	38.5	0.0	0.0	53.9	0.0
Madhya Pradesh	82.4	17.7	0.0	0.0	0.0	0.0
Manipur	0.0	16.7	0.0	16.7	66.7	0.0
Nagaland	16.7	0.0	0.0	0.0	83.3	0.0
Odisha	95.8	1.4	0.0	1.4	1.4	0.0
Rajasthan	67.4	6.1	1.5	0.0	24.2	0.8
Uttar Pradesh	19.7	6.1	0.0	0.0	74.2	0.0
Total	**56.2**	**11.2**	**0.7**	**0.5**	**31.1**	**0.3**

Table 23: Percentage of facilities with proper record keeping practices in post-eVIN

State	post-eVIN			
	GoI register	Loose papers	No stock available	Other than GoI register
Assam	95.5	2.3	0.0	2.3
Bihar	89.2	0.0	0.0	10.8
Chhattisgarh	100.0	0.0	0.0	0.0
Gujarat	99.2	0.0	0.0	0.8
Himachal Pradesh	100.0	0.0	0.0	0.0
Jharkhand	100.0	0.0	0.0	0.0
Madhya Pradesh	100.0	0.0	0.0	0.0
Manipur	100.0	0.0	0.0	0.0

State	post-eVIN			
	GoI register	Loose papers	No stock available	Other than GoI register
Nagaland	100.0	0.0	0.0	0.0
Odisha	98.6	0.0	1.4	0.0
Rajasthan	96.2	0.8	0.0	3.0
Uttar Pradesh	95.5	3.0	0.0	1.5
Total	**97.4**	**0.7**	**0.2**	**1.8**

During pre-eVIN era, only 56.2% facilities utilized Government of India register,whereas, in the post-eVIN period, almost 97% of the facilities utilized the GoI register. It is further encouraging to see that facilities across the 12 eVIN states showed significant improvement in record keeping practices.

Overall improvement in utilizing the GoI registers and reduction in usage of loose papers across facilities after the introduction of eVIN was statistically significant ($p<0.001$). The practice of using loose papers has almost been stopped (reduced from 11% facilities in pre eVIN to 0.7% in post eVIN) across all 12 assessment states.

Qualitative Findings

eVIN system has ensured the standardization of stock registers across 12 eVIN states. District level officers have found this practice good and quoted,"that the dual data recording system have made it authentic". However, a few officials mentioned that cold chain handlers found it hard to do dual entries due to paucity of time.

Vaccine Stock Updating Duration

During pre-eVIN period, only 39% facilities updated vaccine stock on a daily basis,while, during post-eVIN period, 54% facilities updated vaccine stock on daily basis. The facilities reporting weekly (including daily) updating of stock registers had gone up from 72.5% to 81.1% in the post-eVIN phase.

Table 24: Vaccine stock updating duration pre-eVIN, N=617 (percentage of CCH)

State	Daily	Weekly	Bi weekly	Monthly	Not fixed	Any Other	None
Assam	0.0	97.7	0.0	0.0	0.0	0.0	2.3
Bihar	46.0	51.4	2.7	0.0	0.0	0.0	0.0
Chhattisgarh	9.7	19.4	71.0	0.0	0.0	0.0	0.0
Gujarat	53.3	31.7	6.7	1.7	0.0	5.8	0.8
Himachal Pradesh	0.0	4.4	43.5	0.0	0.0	52.2	0.0
Jharkhand	7.7	0.0	92.3	0.0	0.0	0.0	0.0
Madhya Pradesh	80.9	14.7	4.4	0.0	0.0	0.0	0.0
Manipur	0.0	66.7	16.7	16.7	0.0	0.0	0.0
Nagaland	33.3	0.0	0.0	0.0	66.7	0.0	0.0
Odisha	8.5	80.3	1.4	4.2	0.0	1.4	4.2
Rajasthan	59.1	12.9	15.2	0.0	4.6	8.3	0.0
Uttar Pradesh	18.2	21.2	39.4	0.0	0.0	18.2	3.0
Total	**38.6**	**33.9**	**16.9**	**1.0**	**1.6**	**7.0**	**1.1**

Table 25: Vaccine stock updating duration post-eVIN, N=617 (percentage of CCH)

State	Daily	Weekly	Bi weekly	Monthly	Not fixed	Any Other	None
Assam	2.3	90.9	6.8	0.0	0.0	0.0	0.0
Bihar	97.3	0.0	2.7	0.0	0.0	0.0	0.0
Chhattisgarh	58.1	12.9	29.0	0.0	0.0	0.0	0.0
Gujarat	60.8	25.8	6.7	0.8	0.0	5.0	0.8
Himachal Pradesh	43.5	0.0	4.4	0.0	0.0	52.2	0.0
Jharkhand	38.5	0.0	61.5	0.0	0.0	0.0	0.0
Madhya Pradesh	86.8	8.8	4.4	0.0	0.0	0.0	0.0
Manipur	16.7	66.7	16.7	0.0	0.0	0.0	0.0
Nagaland	33.3	0.0	0.0	0.0	66.7	0.0	0.0
Odisha	14.1	83.1	0.0	2.8	0.0	0.0	0.0
Rajasthan	68.9	8.3	13.6	0.0	0.8	8.3	0.0
Uttar Pradesh	36.4	22.7	19.7	0.0	0.0	21.2	0.0
Total	**53.5**	**27.6**	**10.5**	**0.5**	**0.8**	**7.0**	**0.2**

It is evident from the tables 24 and 25 that CCHs are updating stock registers more efficiently and in a timely manner. The rigorous training provided to the CCHs have attributed in this positive action. CCHs are comfortable in using stock registers and understand the importance of timely updating.

Voices From the Field

"For cold chain, there used to be 4-5 different registers that we had to maintain. But now the register we got are according to the Indian Government guidelines and it is easy to maintain. We trained the cold chain handlers, on boarded them to system and within same day everybody started making the entries, batch numbers and doing batch management which is a big achievement we experienced."

District Immunization Officer

"CCH is on his toes most of the times and now they have to make similar entries two times. Once in app and then in register. I think the mobile data is reliable but manual entries should not stopped"

District Immunization Officer

Takeaways

- *Stock documentation practices have been improvised across 12 eVIN states.*
- *100% CCHs are comfortable with standardized stock registers and updating on every transaction.*

3.7 Documentation: Completeness and Accuracy

The Ministry of Health & Family Welfare, GoI has developed certain formats for recording and reporting of information related to UIP at all the cold chain points. The cold chain handlers are mandated in maintaining the following:

- Vaccine Stock Register
- Vaccine Distribution Register
- Temperature Log Book
- Log Book for Cold Chain Equipment
- Vaccine & Logistics Indent Form

Of them, three registers (stock, indent and temperature log book) have been analyzed for completeness and accuracy in the assessment.

A. Completeness: The form completeness was checked in terms of identified indictors in relevant field by a physical check at CCP level. Data completeness was categorized as a) more than 90%, b) between 80 to 90%, and c) below 80%, based on missed entries of critical indicators in relevant registers. Above 90% completeness indicated less than or equal to 10 instances missed for critical indicators; 80% to 90% indicated less than or equal to 20 instances missed and below 80% indicated more than 20 instances missed.

Indent Form

Indent form is used to generate indent of vaccines that are required to conduct immunization sessions or to demand vaccine in case of stock-out/minimum stock of vaccines. Completeness of indent form was assessed based on missed recording of critical indicators. 'Above 90% completeness' indicated less than or equal to 10 instances missed of four critical indicators- amount demanded, closing balance, total amount received and date of indent.

Figure 27: Percentage of CCPs in the state with more than 90 % completeness of Indent forms

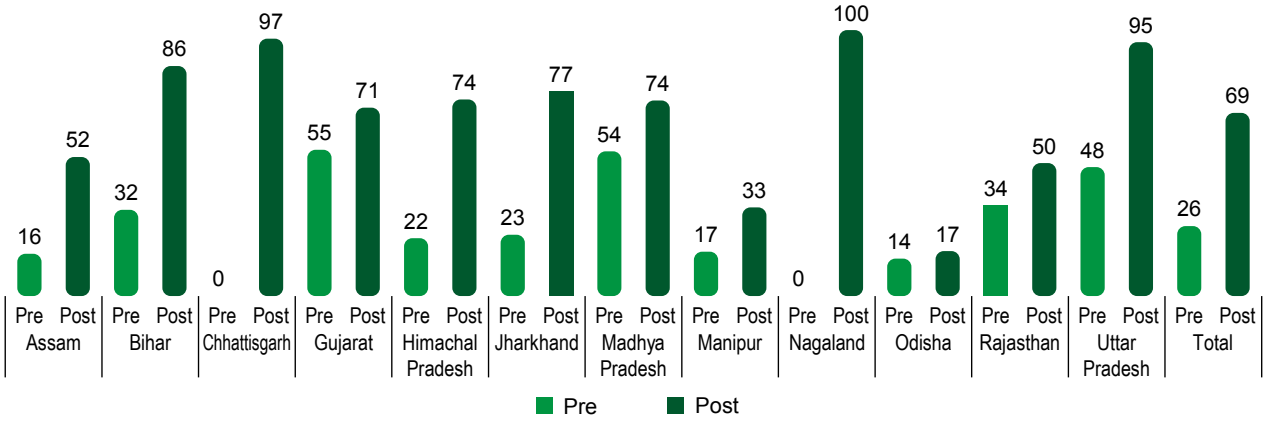


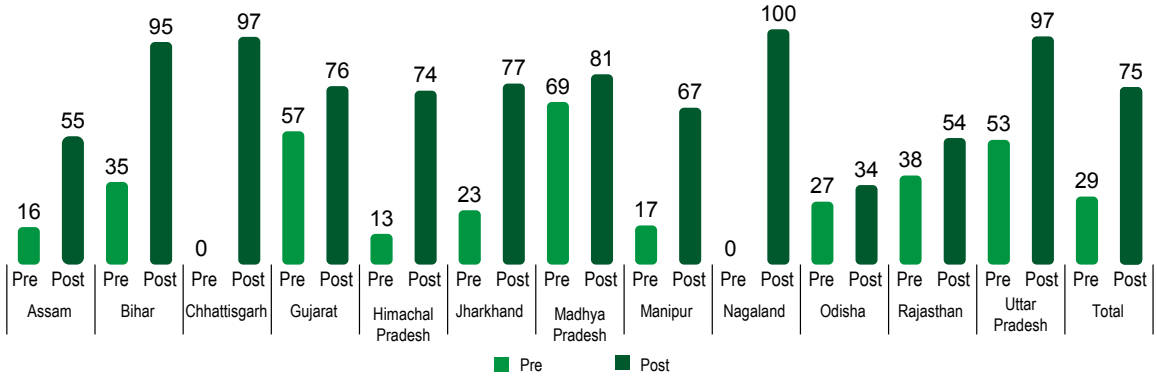
Figure 27 showed that the percentage of CCPs with more than 90% completeness of indent forms had increased from 26% in pre-eVIN to 69% in post-eVIN ($p<0.001$). The highest improvement was evident in Nagaland (from 0% to 100%) followed by Chhattisgarh (from 0% to 96.8%) and Uttar Pradesh (from 48% to 95.0%).

Vaccine Stock Register

A systematic record is available with all cold chain handlers to record information such as vaccine stock and inventory details including opening stock, amount received, from where stock was received, batch number, expiry, and closing

balance etc. 'Above 90% completeness' indicated less than or equal to 10 instances missed of six critical indicators, which are batch number, expiry date, VVM status, opening balance, closing balance and open vials (at CCP).

Figure 28: Percentage of CCPs in the state with more than 90% completeness of vaccine stock registers



In figure 28 it is observed that data completeness significantly improved from 29% in pre-eVIN to 75% in post-eVIN in all eVIN states ($p<0.001$). Maximum improvement was observed in Nagaland (from 0% to 100%) followed by Chhattisgarh (from 0% to 96.8%).

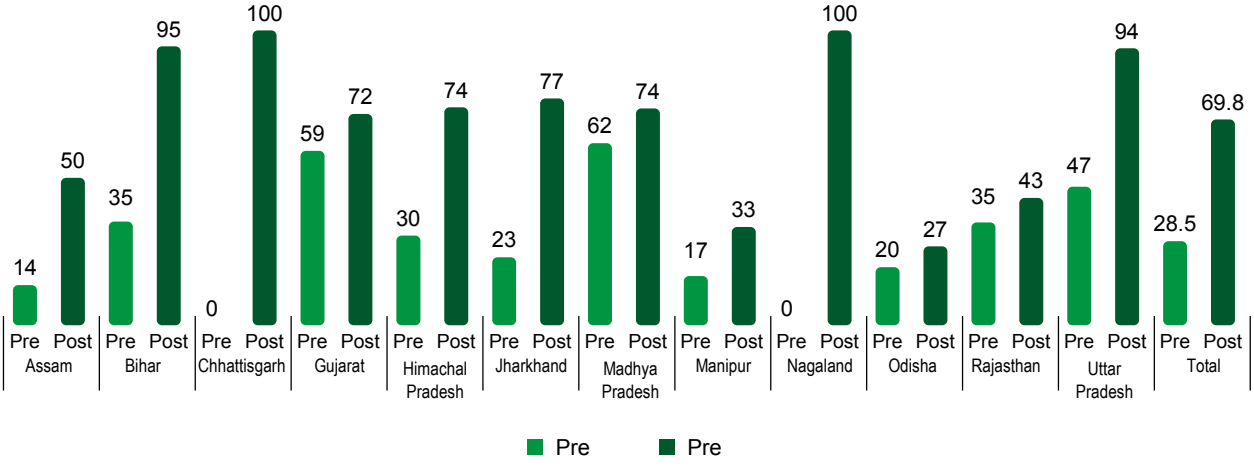
Temperature Log Book

According to UIP guidelines, the temperature is to be monitored and recorded in temperature logbook twice, daily on all days of the week, including Sundays and holidays. A temperature logbook for each cold chain equipment using functional thermometer or digital devices was provided under the national program.

Completeness of temperature logbook was assessed based on whether temperature was plotted in the morning and evening as mandated, whether defrosting and preventive maintenance records are maintained as mentioned. 'Above 90% completeness indicated less than or equal to 10 instances of temperature recording as being missed from the log book.

Figure 29 showed that completeness of the temperature logbook significantly improved from 28.5% in pre-eVIN to 70% in post-eVIN acrosse VIN states ($p<0.001$). The highest improvement was observed in Nagaland and Chhattisgarh (from 0% to 100% in each of the state) followed by Bihar (from 35% to 95%) and Uttar Pradesh (from 47% to 94%).

Figure 29: Percentage of CCPs in states with over 90% completeness of Temperature log book



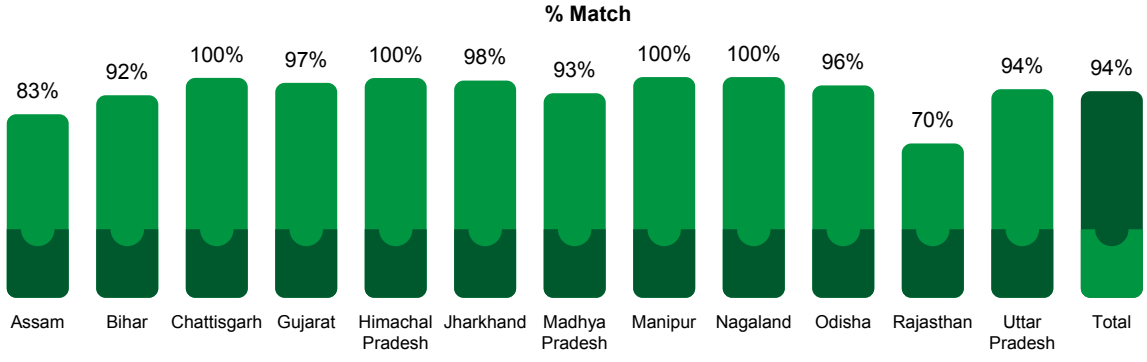
B. Accuracy: The accuracy of the recording and reporting of the stock was verified on the day of visit to the Cold chain points by tallying vaccine-wise stock kept in Ice Lined Refrigerator (ILR) and their information recorded in stock register and eVIN record.

Two different comparisons were carried out to check the accuracy of stock: One between stock register and eVIN record and another between eVIN record and physical count.

Between Stock Register and eVIN Record

In this comparison, vaccine-wise total stock recorded in stock register is compared with vaccine-wise total stock recorded in eVIN record. According to comparison, percent match is calculated.

Figure 30: Percentage of CCPs across states with match between stock register and eVIN

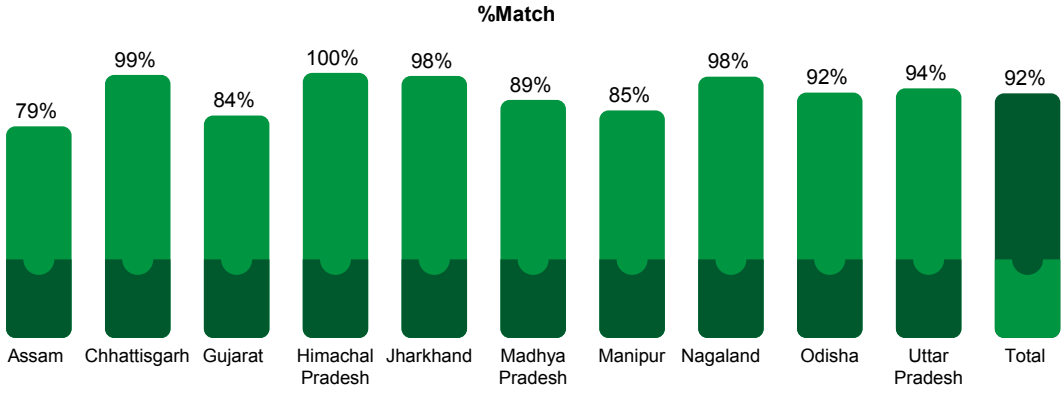


Findings in Figure 30 showed an overall93.6% match in all eVIN states being observed. Only Assam and Rajasthan demonstrated less than 85% match in terms of their record keeping practices. In Rajasthan, the percent match was less because of unavailability of VCCM at the time of assessment. VCCM helps in monitoring and supportive supervision and overall coordination between all CCHs at CCPs.

Between eVIN record and Physical Count

Physical stock count of each vaccine kept in ILR and DF at CCPs was done by the field investigator and the findings corroborated with the eVIN record.

Figure 31: Percentage of CCPs with match between eVIN and physical count



Overall, 92% facilities have shown match of count with eVIN update across all eVIN states in Figure 31. Only Assam and Gujarat demonstrated less than 85% match in terms of count and eVIN system update.

Takeaways

- *Standardized registers were found across all levels of immunization supply chain*
- *Completeness and accuracy of stock data is remarkable across eVIN states*

3.8 Temperature Monitoring

An essential aspect of successful vaccine logistics lies in a healthy and functioning cold chain system(refrigerators, cold rooms, coolers, and their associated support equipment) to remain potent and safe to use. Correct, reliable, and consistent monitoring of temperature of cold chain equipment wherever and whenever vaccines are manufactured, stored, transported and used are an important activity to ensure that potent and effective vaccines reach the beneficiary. Temperature monitoring is therefore not a one-off activity but a continuous task that must be responsibly carried out at every level.

It is therefore important to ensure that:

- Temperature of Ice-Lined Refrigerator measures between 2°C and 8°C.
- Freezer temperature measures -15°C to -25°C.
- Vaccines meant to be stored in the refrigerator should never be frozen.
- Temperatures of the refrigerator and freezer should be checked at least twice daily and documented on a temperature log.

To assess the situation in temperature monitoring, an eVIN and non-eVIN comparative assessment was deployed. A pre-eVIN vs post-eVIN comparison could not be undertaken as UNDP was unable to share the records of temperature breaches from early eVIN and post-eVIN period due to data confidentiality and sensitivity.

Temperature Monitoring and Recording on Routine Days and Holidays

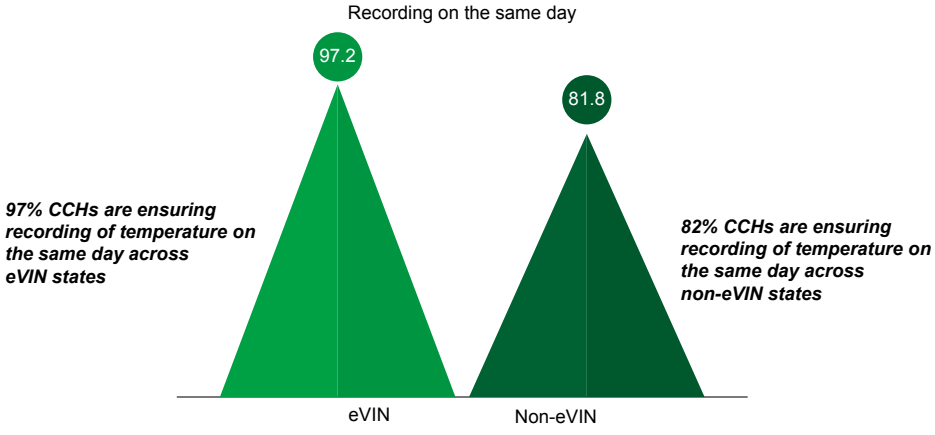
Traditionally, stem thermometer is used to measure the temperature of cold chain equipment and readings are recorded in the temperature log book twice a day, i.e. morning and evening. However, installation of eVIN data loggers by UNDP enabled real-time information on temperature of cold chain equipment, to monitor even from a remote distance and thereby made the cold chain management a more robust, effective and implementable system.

The assessment tried to get an insight into how temperature of cold chain equipment was monitored and documented in various states on routine days & on holidays. Further, to understand variation in temperature readings, stem thermometer and eVIN data logger readings were matched for knowing accuracy.

Two rounds of physical inspection are to be conducted every day in the facility to ensure temperature of each cold chain equipment are maintained within the prescribed range and the readings as observed by stem thermometer are documented in the temperature log book on the same day.

However, physical monitoring of temperature of cold chain equipment and documenting these readings in the logbooks becomes difficult on a weekly basis and/other holidays. Hence, as a routine practice, one of the staff members at the facility will visit the cold chain facility to physically monitor the temperature of cold chain equipment and record it in the logbook. There are also facilities where physical temperature monitoring of cold chain equipment are either not carried out on holidays or if carried out, it is not recorded in the logbook on the same day.

Figure 32: Percentage of CCHs recording temperature readings of CCEs on the same day (including Holidays) on daily basis



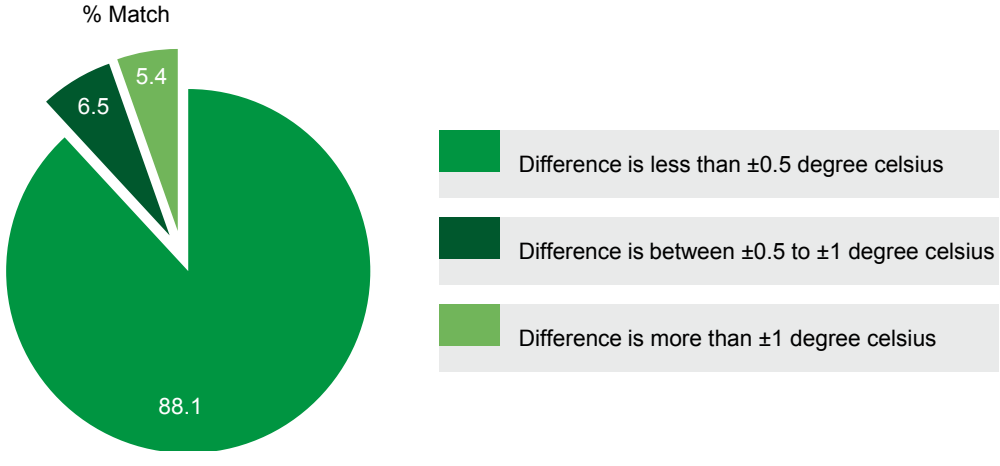
As depicted in the Figure 32, it was found that around 97.2% facilities spread across eVIN states ensured recording the temperature readings in the log book on the same day, whereas only 81.8% of cold chain facilities have ensured the same in the non-eVIN states. Overall better temperature recording on the same day as a practice has been observed after the introduction of eVIN and the finding is statistically significant ($p<0.001$). This shows efficient temperature management across eVIN states in comparison to non-eVIN states. At all CCPs across eVIN states, real time temperature recording was also being noted using temperature loggers.

Accuracy of Temperature: Percentage of CCPs, Where eVIN Logger Reading Matched with Stem Thermometer

To check the accuracy of temperature reading of eVIN logger and Stem thermometer, readings of both eVIN logger and Stem thermometer were compared. Figure 33 revealed that:

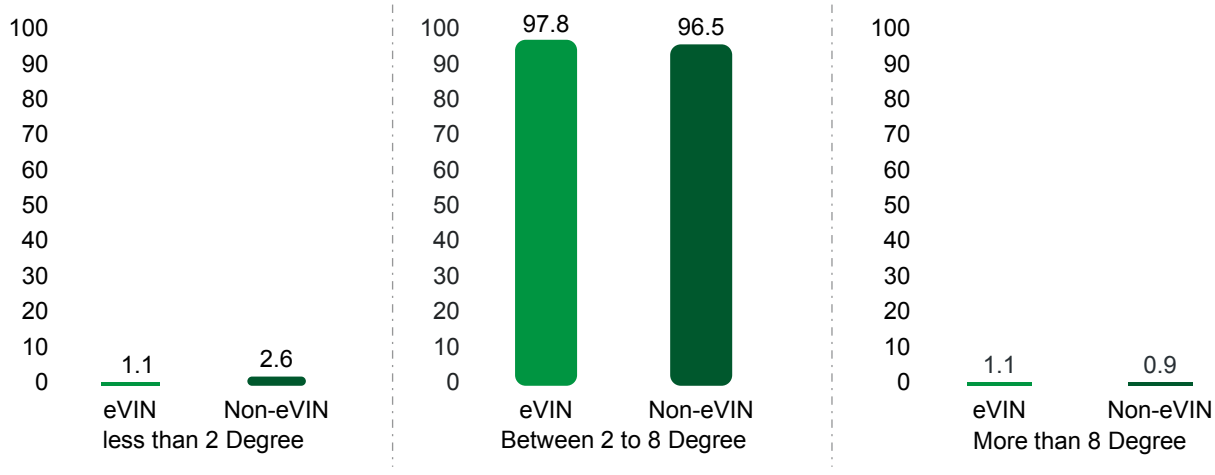
- 88% accuracy considering +/- 0.5-degree deviation has been observed between temperature reading of stem thermometer and of eVIN data logger.
- ~7% readings have shown deviation between +/- 0.5 to +/-1 degree
- ~ 5% reading showed deviation by more than 1 degree

Figure 33: Percentage of CCPs with match between temperature reading of eVIN logger and Stem thermometer



Below graph in Figure 34 showed that majority of the stem thermometer indicated temperature between +2 to +8 o centigrade, 97.8% across eVIN states and 96.5% in non-eVIN states signifying the fact that there was no difference in temperature breaches between eVIN and non-eVIN states. A 'cold chain breach' was said to have occurred if vaccine storage temperatures have been outside the recommended range of +2°C to +8°C. Only 1% of CCE in eVIN states have reported temperature less than 2 degrees Celsius, while 2.6% of CCE across non-eVIN states have reported less than 2 degrees. Also, 1% of CCEs across eVIN and 0.9% of CCEs across non-eVIN states have shown temperature more than 8 degrees Celsius.

Figure 34: Percentage of CCPs with observed Stem Thermometer readings in the recommended temperature range



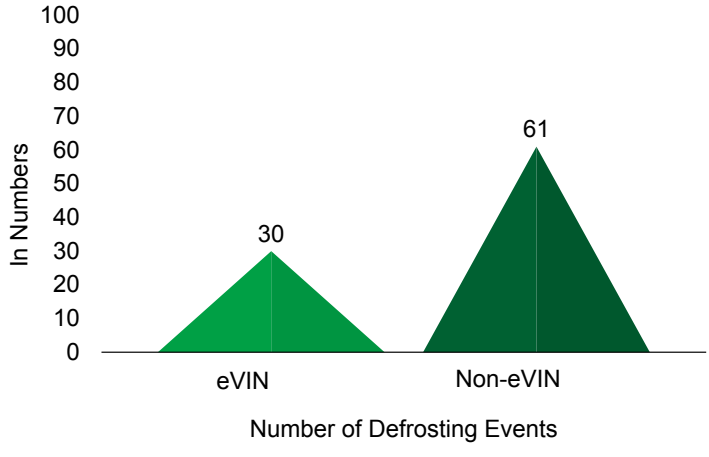
Defrosting events in Cold Chain Equipment

Vaccine refrigerators are known to work well only if properly cleaned and defrosted regularly. Thick ice in the freezer compartment does not keep the refrigerator cool, and it makes the refrigerator work harder with the use of more power. Hence, it is important to defrost the refrigerator once a month or when the ice becomes more than 0.5 cm thick.

In the case of defrosting or equipment failure, vaccines are shifted to alternate equipment. The below graphs in Figure 35 showed the defrosting instances:

- Comparative analysis of eVIN versus non-eVIN states on instances of defrosting demonstrates non-eVIN states have more instances of defrosting. It further showed that health of CCE in non-eVIN states is poor in comparison to eVIN.

Figure 35: Number of instances of defrosting in pre-eVIN versus post-eVIN period



Qualitative Findings

Use of eVIN in Temperature Monitoring

Majority of state and district officials appreciated the installation of temperature loggers due to which temperature monitoring have become easy. They mentioned that real-time temperature monitoring at dashboards have made them capable of taking prompt remedial actions when needed. Temperature fluctuations are often notified both through dashboards and mobile phones. They further added that because of real-time temperature being recorded, they could monitor the guideline protocol compliance being actioned by the CCT and incase of mishaps in the dashboard, these can be rectified in a timely manner from a distance via one telephone call. Installation of temperature loggers on site has proved to be even more beneficial in the case of remotely located cold chain points.

The district officials further mentioned that hourly notification and separate hot and cold temperature alarms have made it easy for them to take timely required actions during breakdowns. For example, if a power cut lasts beyond two hours, it becomes mandatory to shift the vaccines to either a cold box or to the next CCP. Officials also stated that they could monitor the health of CCE after the roll-out of eVIN. It was further observed that there was a marked increase in uptime of cold chain and reduction in break down.

Voices From the Field

"Now I can see hourly status of temperature online. In case of any deviation, I can alert CCHs in a moment. Before eVIN there were many instances of wrong temperature recordings. At one point of time we were dependent on villagers to notify us in case of power failure when CCH was on leave or if it was any public holiday."
District Immunization Officer

Takeaways

- *Better record keeping of temperature and real-time temperature monitoring across eVIN states in comparison with non-eVIN states.*
- *Data accuracy among data logger and stem thermometer is good considering deviation of +/- 1degree Celsius.*

3.9 Cold Chain Equipment

The system used for keeping and distributing vaccines under potent temperature condition is called the 'cold chain'. Hence, a completely functional and well maintained cold chain system for receiving and safely storing vaccines must be in place. Immunization supply chain management in the country relies on a vast infrastructure of cold chain equipment. This section will focus on the health of CCE and details of associated equipment.

Sickness Rate is an indicator for health of cold chain equipment. It is a proportion of cold chain equipment that is out of order, at any point of time, out of total functional equipment. The sickness rate is kept to the minimum acceptable level of less than 2%. As shown in Figure 36:

- The assessment of cold chain facilities revealed that eVIN states have reported sickness rate of 1.9% within the acceptable limit.
- However, 3.4% sickness rate was reported across non-eVIN states that are way beyond the acceptable limit.

This is indicative of better upkeep of equipment, improved reporting of breakdown of equipment, timely repairs and reduced time for cold chain equipment in the eVIN states when compared with non-eVIN states.

Figure 36: Variation in sickness rate of Cold chain equipment across eVIN versus non-eVIN States

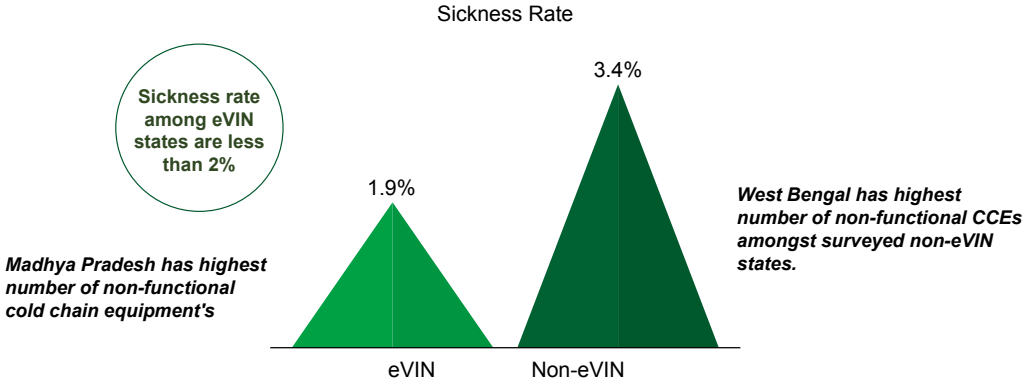
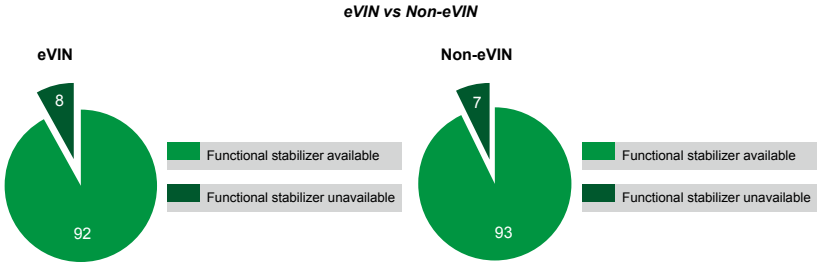


Figure 37 Percentage of Equipment with functional stabilizers in eVIN and non-eVIN states



The above figure 37 demonstrates that both set of comparative states have functional stabilizers.

Qualitative Findings

According to state Government condemnation guidelines, cold chain equipment that are obsolete or unserviceable should be condemned by state/district level committees. But, it was observed that many cold chain equipment that are beyond repair are unnecessarily occupying space in the vaccine stores in many states.

Takeaways

eVIN states have reported sickness rate aligned with GoI standards of less than two percentage.

3.10 System Handling

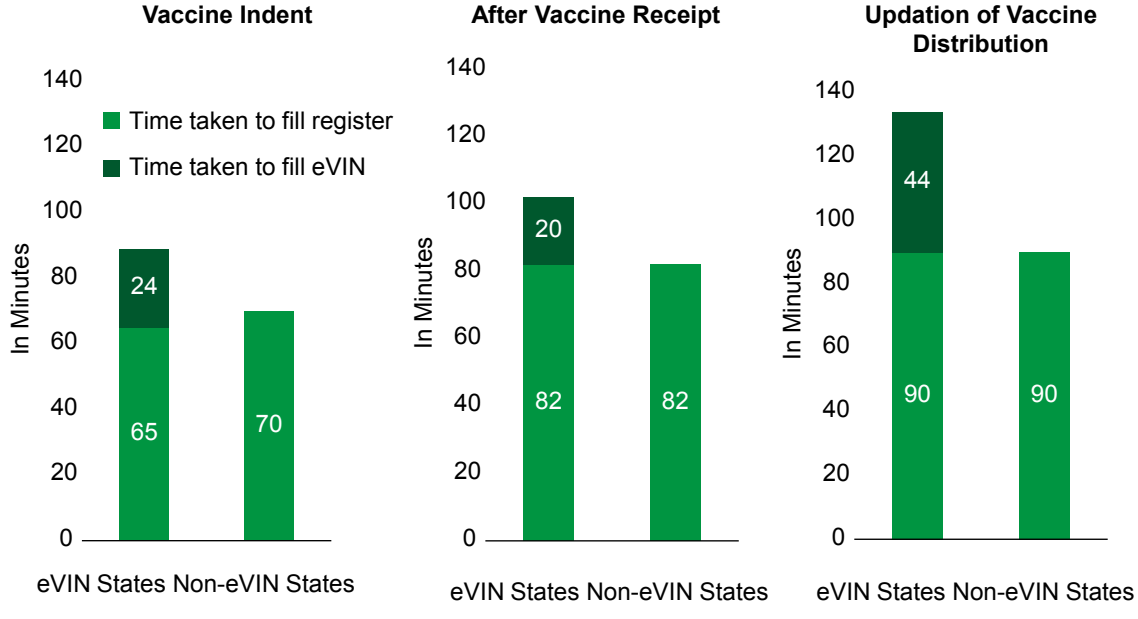
This chapter is divided into four sections: (1) time taken to update information of vaccine stock in eVIN and in register; (2) rating of eVIN application; (3) eVIN performance; and (4) ease of using eVIN application.

Time Taken to Update Information of Vaccine Stock in eVIN and in Registers

The assessment was carried out to estimate the usual time required in updating the information in register as well as eVIN system for indenting, vaccine issuing/receiving and distributing by CCH. This comparison was done between CCPs of eVIN and non-eVIN states. Findings showed that filling information in eVIN application takes much lesser time in comparison to filling hard copies.

- Time required in preparing an indent: Time taken to generate an indent in eVIN states was higher as compared with eVIN system. It was observed that additional 24 minutes was consumed to generate indent and update the information in eVIN and register in eVIN states, as shown in Figure 39.
- Time required for updating register after receipt/issuance of vaccines at CCPs: Time taken to update information of vaccine received in eVIN states was more than non-eVIN states because of dual recording of information in eVIN application as well as in the register. Overall 20 more minutes was required to update the information in stock, as shown in Figure 38.

Figure 38: Time required to update eVIN and registers



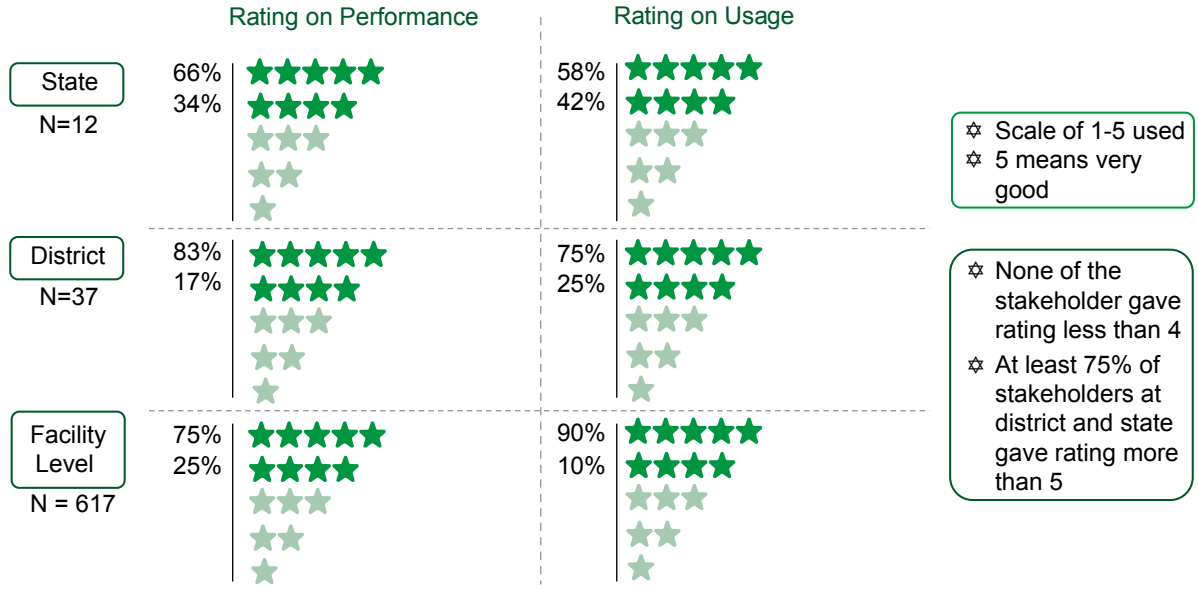
Time Required for Updating Vaccine Distribution Information

Time taken to update information on vaccine distribution in eVIN states was higher as compared with time taken to update information of vaccine distribution in non-eVIN states. It was observed that an additional time of 44 minutes was consumed to enter information in eVIN, as shown in Figure 39.

Rating of eVIN Application

Rating of eVIN was done using the 'Likert scale' on performance of eVIN application and in terms of ease of using the app; where '1' denotes 'very bad' and '5' denotes 'very good'. Rating of eVIN application was done at three different levels i.e. state, district, and facility level.

Figure 39: Rating of eVIN application on performance and usage at different levels of supply chain



a. State level:

- Performance of eVIN application- A rating of 5 was received from eight states (66%) and four states (34%) have rated 4.
- Ease of use- A rating of 5 was received from seven states (58%) and five states (42%) have rated 4.

b. District level: Out of 37 districts in 12 selected eVIN states,

- Performance of eVIN application- 83% of districts have rated 5 and 17% of districts have rated 4.
- Ease of use- 75% of districts have rated 5 and 25% districts have rated 4.

c. Facility level: Out of 617 CCPs in 12 eVIN states:

- Performance of eVIN application- 85% cold chain handlers have rated 5 and 25% cold chain handlers have rated 4.
- Ease of use- 90% cold chain handlers have rated 5 and 10% have rated 4.

Takeaways

- *Time taken for entry in eVIN software is less against the time taken for entry in registers. Government may consider print-outs of eVIN once it is fully rolled-out*
- *Most of the users of eVIN application rated it high on performance*
- *The eVIN app is quite user-friendly.*

3.11 Qualitative Assessment

A. Programmatic Benefits

It is evident from the data that eVIN has been successful in changing the whole vaccine management system. The findings from detailed discussions from stakeholders revealed many quantifiable and non-quantifiable benefits of the program. To understand the overall programmatic benefits of eVIN for the states, the responses from all stakeholders are categorized under direct and indirect benefits.

eVIN system played a direct role in improving overall management of vaccines in the states through following ways:

1. **Capacity building:** Roll-out of eVIN was initiated with calculations of available human resources and defining capacity building needs at all levels under immunization programme. Following eVIN roll-out, a cold chain network across the states was empowered by building capacities of government cold chain handlers and by deploying vaccine and cold chain managers (VCCMs) in every district to estimate vaccine requirements, supervising cold chain handlers and to coordinate with cold chain technicians across the district. Respondents were of the opinion that the trainings have helped the staff to standardize the vaccine and cold chain practices and make them self-sufficient to update the registers on time and follow the standard record keeping mechanism.

> ***Voices From the Field***
>
> *"All the trainings were monitored by state level staff and UNDP officials. Hands on training were provided to CCHs regarding software management and handling equipment. Initially there was a problem faced by aged cold chain handlers in using mobile phones but VCCM put in a lot of efforts to make everyone understand every detail of the system."*
> ***District Immunization Officer***

2. **Stock management:** eVIN implementation in states has provided details on real-time stock availability and information on stock-outs and overstocks. Prior knowledge of stock data has also simplified smooth distribution and lateral sharing of vaccines at various CCPs according to usage and requirement numbers. Respondents mentioned that this knowledge has also helped them focus more on avoiding overstocking at CCPs rather than demanding more from state. Real-time information on stock outs and overstocks have helped in a tremendous reduction in wastage. Respondents pointed that known stock numbers have led to apt use of FIFO and FEFO and utilization in right time.

> ***Voices From the Field***
>
> *"A few months ago, it happened that DPT antigen was about to expire. If it was not eVIN then all of it would have gone waste. As soon as we got to know this, we organized camps and managed to use whole stock before it expired.*
> ***District Immunization Office***

3. **Temperature monitoring:** With eVIN comes the temperature loggers that help in easing out the process of temperature management by timely tracking of temperature of CCEs and constant reminders through notifications for temperature fluctuations. Temperature loggers have helped states in real-time and remote monitoring through eVIN dashboards. Temperature graphs and trends generated through eVIN dashboards have helped in developing timely contingency plans. Respondents mentioned that hourly notification and separate hot and cold temperature alarms have helped in regular monitoring to take timely actions and prevent the vaccine wastage. Temperature monitoring has also contributed in improving overall health of CCEs by increasing the uptime of cold chain and reductions in CCEs breakdown.

Voices From the Field

"Power cut lasting less than 2 hours usually don't change the temperature, good thing about the system is that it notifies well in time to transfer vaccines in cold box or at another CCP"
District Immunization Officer

Some of the indirect benefits highlighted by the respondents are as follows:

1. **Overall programme planning and management:** State level officials stated that eVIN generates reports on 9 key indicators. They believed that information provided by these reports have been helpful in effective implementation of immunization program and ensuring potent vaccines reach the beneficiaries on time. District officials further mentioned that eVIN has helped them in revising the due lists of beneficiaries, which in return helped the officials to estimate the number of vaccine doses required in a particular session and in subsequent sessions.

   All respondents acknowledged that connectivity of their smartphones from the health facilities with eVIN data and dashboards was now their mainstay for helping in taking decisions related to procurement and distribution of vaccines, and regarding health of cold chain equipment. Key officials accepted that before eVIN, vaccine supply chain and entire cold chain system had scarcity of trained human resource, poor stock visibility, poor temperature monitoring and poor planning for vaccine distribution. Additionally, the storage conditions were also not appropriate for vaccines. They stated that previously their planning process had never been as effective and efficient as is now equipped with requisite technological platform, skilled staff, real-time information on vaccine stock and storage temperatures. A few respondents also agreed that the meticulous planning that followed eVIN reports eventually led to reduction in the number of stock-outs resulting into a greater number of beneficiaries getting vaccinated.

Voices From the Field

"There are possibilities of human errors and sometimes employees are ignorant towards their duties which ultimately affects the beneficiary who receives the vaccines. We need 24/7 surveillance to ensure 100% quality and 0% wastage."
District Immunization Officer

   Proper planning helps in successful execution of routine immunization plan. The state and district officials were asked about their opinion regarding the usefulness of eVIN in UIP planning, to which almost all respondents mentioned that eVIN has resulted into digitized stock management and has made real-time information about the vaccine stock and distribution available, which further aids in planning vaccine campaigns according to the need of the community. A few stakeholders said they now receive timely alerts on expiry of vaccines. This information also helped them in planning and organizing immunization camps in accordance with FEFO.

2. **Better monitoring mechanism:** eVIN is considered as a good platform for real-time monitoring of the key indicators like stock position, indenting, wastage, discarding without being dependent on the CCH. Almost all the stakeholders acknowledged the fact that knowledge of health of CCE, which was often neglected in pre-eVIN time, was one of the biggest assets of eVIN. They further mentioned that the dashboard was like a mirror to reveal the status of temperature. They were highly appreciative of the automated system that keeps the equipment at recommended temperature and even the slightest fluctuations come to their notice very soon.

   State and district officials were quoted saying that eVIN has eliminated the chances of errors or wrong entries by the frontline health workers. Most of the stakeholders with responsibility of monitoring, mentioned that they were also involved in day to day governance which has led to a snag in their performance in recording data entry time. This was validated by the officials assessing the temperature graph on the dashboard and subsequently the responsible person being notified immediately via WhatsApp group and if necessary, a letter being issued to the BMO. They further mentioned they were involved in checking the supervisory checklist and giving feedback on

data at various levels. District officials also made a mention of the VCCMs role in timeliness and completeness of routine reporting including updation of stock, temperature and indent register.

Majority of respondents mentioned that they critically monitor the supply of vaccines to CCP, including the vaccine distribution vis-a-vis vaccine utilization, minimum, maximum and critical stocks, and vaccine wastage rates. A few respondents also mentioned they additionally monitored the implementation of "Open Vial Policy". Respondents stated that they ensured both the quality and potency of vaccines in the CCE by regular monitoring of storage temperatures, equipment health, status of equipment defrosting, reverse cold chain, and Alternate Vaccine Delivery System (AVDS). They specified that by using eVIN, they ensured vaccines remain potent at every possible level till the time they reach the beneficiaries.

Voices From the Field

"Let me give an example. MR vaccines camps were held in the month's end. However, there was abundance of measles vaccine doses available at all levels. I immediately gave orders to redistribute the measles vaccine and so we were able to consume all the doses before measles vaccine was discontinued and replaced by new MR vaccine."
State Immunization Officer

3. **Improved Supportive Supervision:** Key stakeholders responsible for supportive supervision from various levels included:

- National Level: Officials from MoHFW / ITSU / NCCVMRC /NCCRC / UNICEF / WHO / UNDP / BMGF / PATH / JSI / other stakeholders.
- State Level: SEPIO / CCO / SIHFW / UNICEF / WHO / other stakeholders/SVLM
- District Level: DIO / CCT / SMNet / VCCM/ Other relevant stakeholders
  - Medical Colleges: Government and Private Medical Colleges roped in through formal process by State Government / UNICEF for Supportive Supervision

Respondents mentioned that the primary stakeholders involved in supervision of eVIN implementation are DIO, VCCM, PO-UNDP, MOIC, BMO and SMO. VCCMs have made a WhatsApp group where guidelines and updates of eVIN software are regularly shared with all concerned stakeholders from time to time. DIOs specified that they prioritized their supervisory visits depending on CCPs with temperature excursions and unmatched stock balances. Refrigeration technicians stated they had good coordination with CCHs and in case of any breakdown they would get a call from CCH. If the problem could be addressed on a call, then necessary instructions are conveyed to CCH, however in case when it is not managed on a call then the CCT visits the CCP to repair the equipment. Refrigeration technicians also stated that they are in contact with VCCM to provide them technical assistance, whenever required.

Voices From the Field

"One month ago, SVS gave 8000 doses of Hep – B vaccines with due expiry in one month. Our consumption is only 1000 dose at district level and it was not possible for us to consume whole lot of vaccine in that month. With eVIN population needs are known and I could manage to distribute all vaccines in due time and thus a lot of vaccines were prevented from getting waste."
District Immunization Officer

4. **Review Mechanism:** Most of the state and district level program managers mentioned that the key points covered during review meetings included: monthly coverage data from HMIS portal and its analysis, findings from supervisory visits, vaccine stock records, temperature records, registers from the field, parent child /mother newborn tracking data, list of missed children, data related to any evaluations, assessments and surveys conducted. State officials also mentioned that DIO was the programme leader at district level and supervises refrigerator

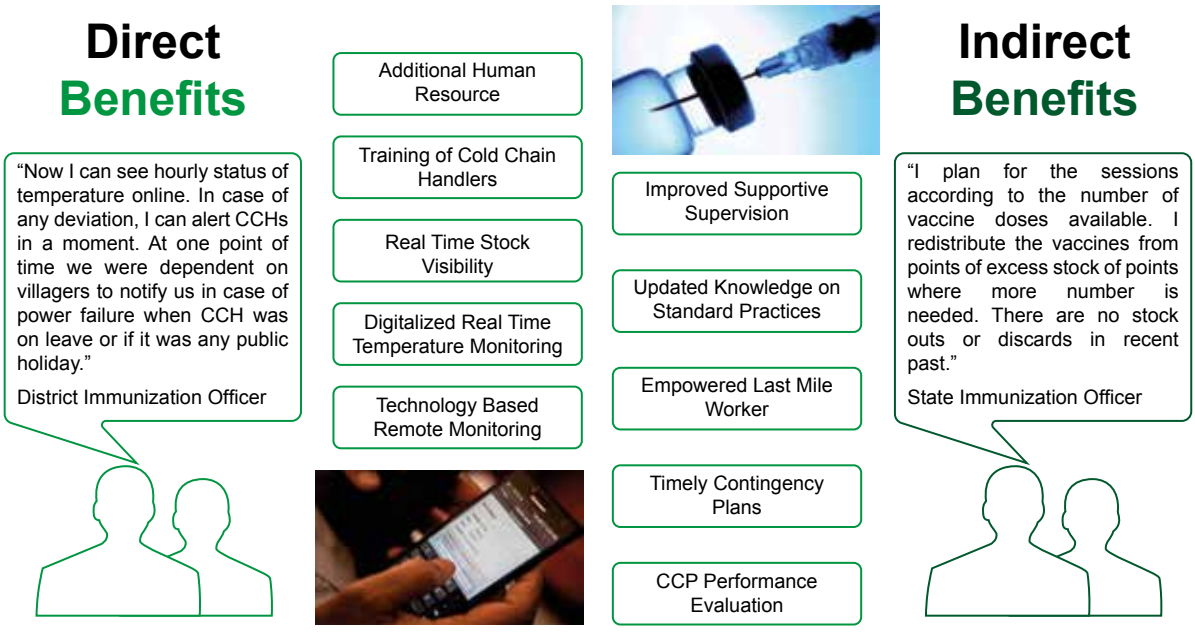
technician, district vaccine storekeeper and VCCM. Their work included visit to different CCPs with a checklist. The DIOs assess, conduct audit, and undertake corrective actions and based on the monthly review, CCHs with less knowledge are identified and given on-the-job training.

District officials reported that monthly block review meeting takes place during the first week of every month where performance of entire facility staff is carried out. They shared weekly updates and monthly utilization of vaccines from CCPs. Additionally, there were weekly meetings with VCCM, usually on a Saturday, and areas of discussion generally included vaccine utilization, number of sessions planned and held, and immunization coverage. Alongside, RCHO also conducts regular field visits at the session sites and CCP.

Voices From the Field

"I know thermostat settings and keep tabs on rising temperature when equipment door is opened. This is the best thing about eVIN. Second best part of eVIN is that you can assess the time of opening the lid of all such machine in the cold chain point in the session day. We can monitor the temperature trend of that time and see whether the timing of opening is as per the time which was expected for opening. This thing can be checked remotely just by sitting at the district HQ or state capital that which time the vaccine was taken out for packing in vaccine carriers. When the lid is opened, we could see a clear rise in temperature for about 15-20 minutes."

Figure 40: Snapshot of direct and indirect benefits



Using eVIN for Quality Assurance

System failure or data discrepancy may cause asymmetry and perceived lack of information at the national and state level. During the assessment, respondents were asked about the strategy they followed for ensuring the quality and corrective actions they undertake when required. The key highlights in this regard are as follows:

Actions needed for Quality Check:

- Regular visits to CCP as part of their Planned Preventive Maintenance (PPM) to check the normal functioning of cold chain equipment Cold chain inventory on the national portal for cold chain (NCCMIS), eVIN and physical matching of their numbers.
- Updating functional status of each machine (CCE) in the NCCMIS and eVIN.

Actions needed for temperature breach:

- Follow up according to SOPs and reference book in case of temperature failure.
- Hot Alarm: Removal of the vaccines from CCE and keeping them in cold box/vaccine carrier with recommended number of conditioned ice packs and timely check and changing of the ice packs.
- Cold alarm: Switching off the start button and opening the door of CCE for adequate time and ensuring proper temperature monitoring, using the open vials first and following the FEFO system.

Actions needed for CCE breakdown:

- Reporting to the Refrigerator Technician
- Raising ticket on online helpdesk in eVIN app
- Replacing sensors only after emptying the ILR, if required.

B. Sustainability

eVIN has been selected as a "best practice" model at the National Summit on Good, Replicable and Innovative Practices and has been recognized as one of the premier scalable models in health care system. It is also considered as one of the best digital innovation under the Ministry of Health and Family Welfare, Govt. of India at the India International Trade Fair 2016.

A sustainable model in vaccine supply chain management is the one that can get integrated into the country's immunization system with or without sparse requirement of extrinsic financial support. In line with the financial support, programmatic sustainability will be possible in cases with higher benefits and lower risks of immunization. This assessment attempts to understand stakeholders' perception about financial and programmatic sustainability of the eVIN system.

Stakeholders who were part of the program since the beginning showed satisfaction to have witnessed the success of program. Majority of the stakeholders were of the view that the demand for vaccination services has increased, but attaining higher coverage levels and equity objectives require additional approaches and framework. Respondents mentioned that to improve the systems, there is a need to ensure adequate supply of affordable vaccines of assured quality, improved efficiencies in service delivery, innovative technology, mobilization of domestic financing and filling remaining funding gaps.

When prompted for key factors that can contribute to sustainable system in future, many respondents highlighted the need for sufficient funds and adequate human resource.

Funds

A robust mechanism of monitoring immunization budget is very important for meeting country-specific action plans for eradication, elimination and control of vaccine preventable diseases (VPDs). Sustained financing for vaccines and immunization is always difficult in the face of competing demands and the constant need to respond to outbreaks and emerging or re-emerging pathogens.

Being a technology-driven system, majority believed funds are necessary for making the system sustainable and demanded additional budget for repair of CCE, mobile phones, replacement of malfunctioning equipment and/or mobile phones to be included in PIP.

They further stated that as technological advancement is an ongoing process, financial support is always helpful in organizing trainings and in providing training materials to keep the staff updated. Additionally, they asked for support in meeting the stationary needs like registers etc.

Voices From the Field

"Dedicated budgetary allocation should be made in the PIP for replacement of 10% of mobiles and eVIN loggers every year, trainings on eVIN (initial training and refresher trainings as a lot of new features are being added to eVIN every year), printing of registers, monitoring and review meetings (as monitoring is critical to success of eVIN)."
State Immunization Officer

Human Resource

Most of the stakeholders mentioned that they were in dire need to strengthen the existing human resource management across the vaccine supply chain with a standard procedure of recruiting, training and retention. They also mentioned that CCHs are overburdened in the present system. They believed new CCHs should be appointed and trained exclusively for eVIN system. Another issue highlighted is the frequent transfer of trained staff. They further demanded for some guidelines about retaining the CCHs at the same CCP for at least three years or replacing them with a trained staff only. A few specifically also mentioned about the requirement of an additional resource at the district level for IT support.

For VCCM: Absorption of VCCM by NHM has been appreciated by almost all the stakeholders and believed it is essential for sustainability. Almost all of the stakeholders believed VCCM should be made accountable for more vaccine and cold chain logistics related activities. They reported that VCCM was one of the most important link in the maintenance system because of their role in seeking action at the time of a break down in reporting it. VCCM was made responsible to take all the possible efforts to communicate the break down to the CCT without any delay.

Voices From the Field

"For scaling up, HR is the main issue. I feel there are issues in CCH work as there is not a proper post anywhere. These cold chain handlers also have other charges with them, for which they are posted. Plus VCCM have been a real good support in the system and I think he is partly responsible for the success of the program."
State Immunization Officer

"It's very important that the coordination among VCCM, CCT and DVSK should be good. Otherwise the whole system will fail. Usually, the CCT and DVSK do not consider VCCM as the part of the programme citing that he is from outside the government department. This way the coordination eventually fails. So, my suggestion would be to engage the VCCM 100% in store activities. There should be an official order that the vaccine should be taken out in his presence and transported. He should be more involved in vaccine transaction and transportation and accountable through authorized signature"
State Immunization Officer

Infrastructure

Key stakeholders believed that electricity back-up, adequate network coverage and proper storage areas are essential requirements and were important to function in an uninterrupted and continuous manner. They believed and mentioned availability of adequate infrastructure was not given the necessary importance when eVIN was first set up. They suggested that infrastructure should not be neglected when attempts are being made to scale up and extend the program to other districts.

Supervision

Stakeholders emphasized the need for intensive supportive supervision along the chain at all levels. They demanded additional supervisory mechanisms and bringing into action systems such as biometrics at each CCP to ensure staff reached and started work on time. They further demanded to have a mechanism in place to check/count the sessions held in a month and believed that manual count was time consuming, tiring and very highly prone to errors.

Equipment

Most of the stakeholders mentioned there were challenges in maintenance of functional equipment. Under the immunization program, it was intended to have minimal equipment breakdown at any point of time, all repairs were responded and repaired within seven days in case of minor repairs, and within 21 days in case of major repairs. In existing program, there is a clear lack of guidelines on the maintenance and replacement of malfunctioned data loggers or other parts of the equipment. Further, there is also no provision of providing additional spare parts like adaptors etc.

A few stakeholders emphasized that as technology has advanced, an attempt should be made to procure CCEs with pre-installed data loggers. The new equipment could also have the thermometer in required position with accurate reading.

> ***Voices From the Field***
>
> *"New equipment should have built in sensor installed just adjacent to the manual thermostat, so that the accuracy of the temperature would be the same in both the systems. This can be done from the manufacturers themselves. The tape which is provided for sensor should be such which could stick to the body better. This tape and other accessories should be there with the VCCM so that the repairs could be done faster."*

C. Challenges

This section details the major implementation challenges that are faced by officials and staff involved in running the system.

Challenges from the field can be broadly divided into two types:

- Challenges addressed and not addressed after eVIN introduction
- Current system challenges

Challenges addressed and not addressed after eVIN introduction

Past studies have documented various challenges in immunization chain system. With this assessment an attempt had been made to understand the technical and implementation challenges which stakeholders were facing in pre-eVIN time. This section details the issues already addressed by eVIN along with the ones that need to be addressed.

Stock Management

In the current immunization supply chain system, managers and officers are responsible for stock monitoring and CCHs are responsible for maintaining vaccine stocks in their CCPs. Many stakeholders mentioned that before eVIN's introduction, managing stock-outs, vaccine indent response time, use of FEFO, CCP to CCP distribution, wastage management and stock update was always difficult.

While eVIN was able to address most of the challenges, the system could be further strengthened to address the following issues:

- Lack of fixed guidelines for getting the required vaccine stocks from DVS to CCPs was reported to be one of the most common challenge faced in the system. It was difficult for CCHs to visit DVSs multiple times to fetch different vaccines due to the presence of multiple vendors for various vaccines. Coordination between the different vendors becomes a challenge in procuring or in collection of vaccines most often done at the vendor's convenience. This not only caused difficulty in conducting timely sessions, but also increases the cost of transport gasoline usage or loss of petrol, oil and lubricant (POL) and man time given to complete the task.

Another challenge reported was the limited powers of district and state level officials to take necessary timely action in case of delays in supply of vaccine from the manufacturer. Reported reasons for the delays are due to the mail based indents generation leaving officials with no idea on the time of indent generation and delays in supply of vaccines. Few stakeholders also mentioned that managing minimum and maximum stocks; and order fill rates was still an issue to address.

Voices From the Field

"CCTs have to go to get the vaccines at least thrice a month. In fact, sometimes he goes upto 5 times. Even then there is no confirmation that he will get all the indented vaccines. This affects his work and all these extra trips could be saved if there is a fixed day of vaccine supply"

Temperature Monitoring

The biggest challenge from the pre-eVIN time were the unknown temperature trends, errors in manual temperature recording, undocumented excursions in temperature and uncharted temperature of cold box. To overcome these challenges, eVIN placed sensors and data loggers in equipment and CCPs respectively. Majority of stakeholders mentioned that all the challenges have been addressed by eVIN except the temperature of cold box. Many district officials had their concern that vaccines may lose their potency if kept out of the recommended temperature range for too long.

Another challenge reported by the district officials and CCTs was a difference up to 2 degrees in stem thermometer and data logger. They mentioned that improper placement of sensor in equipment was the reason for higher temperature on logger. Many a times, CCHs reached CCPs following the alarm and notification instead to only find the temperature within accepted range.

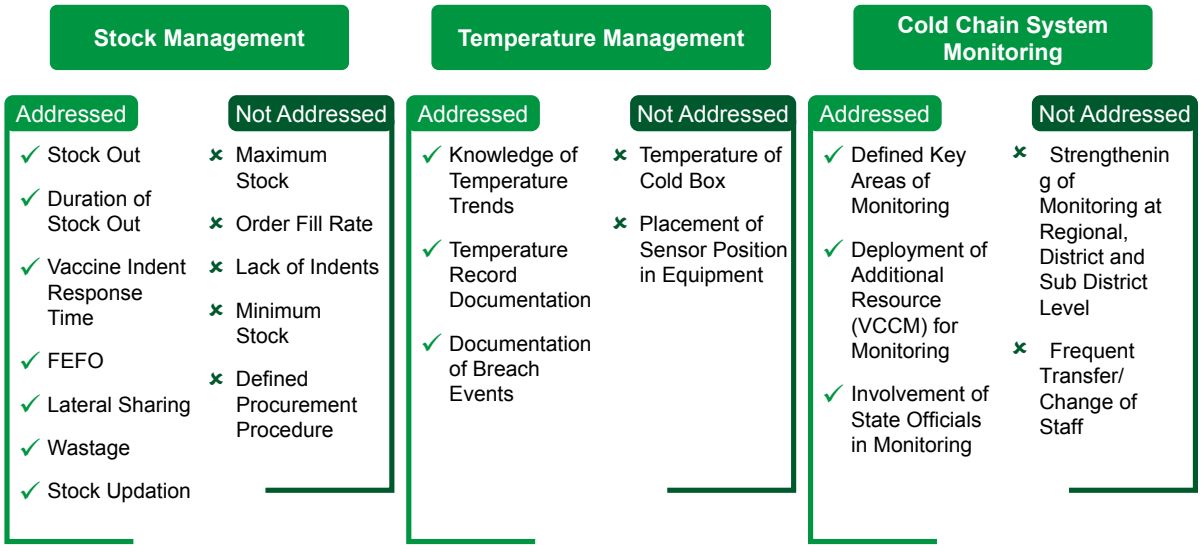
Voices From the Field

"Temperature variation of 1 degrees or even higher in temperature logger and stem thermometer had been raised by Cold chain staff few times. This should be sorted"
State Immunization Officer

Cold Chain System Monitoring

eVIN has introduced new ways of monitoring cold chain system. In pre-eVIN era, cold chain system monitoring lacked dedicated HR and defined areas of monitoring. Involvement of state officials in the process was almost minimal to none. It was found that eVIN was successful in addressing these issues but monitoring by the government counterparts needs to be strengthened. The ownership by the government needs to be enhanced at all levels and accountability needs to be fixed which will improve monitoring across all levels of the immunization supply chain. State and district level stakeholders mentioned that frequent change or transfer of staff was also a challenge in continuous monitoring and added that replacement of trained staff by an untrained staff proved to be a bigger hindrance in an otherwise continuous functioning system of monitoring.

Figure 41: Summary of Challenges addressed and not addressed



Current System Challenges

Major challenges in the system are as follows:

Human Resource and Refresher Training

Skilled human resource is a necessity and requirement for running a system like eVIN. Paucity of skilled human resource was one of the biggest reported challenge in the functioning and running of the system. Stakeholders mentioned that several times they had to make drivers and other unskilled administrative staff in-charge of CCTs.

Majority of state officials mentioned that long intervals in refresher trainings were another challenge and this should be addressed at the earliest. When probed, it was found that most CCHs needed training on data logger and handling equipment.

> ***Voices From the Field***
>
> *"At the district level trainings, I think we should have a monitor to oversee the training. DIO himself is involved in the training, however, there are some quality parameters which are left. So, in two out of five batches, if there is a compromise on the quality, there should be a state or divisional level monitor who can flag the issue and the training could be improved then and there itself."*
> ***State Immunization Officer***
>
> *"It will be good if the trained staffs are not transfer but retained at their present places or appoint separate staffs for eVIN programme only. It will be good if the government arrange training for the staffs from time to time"*
> ***State Immunization Officer***

Network Issues

All the work related to eVIN is largely dependent on network providers and communication. Serious network issues were reported by all the officials. They mentioned that the whole purpose of eVIN gets defeated when the necessary information is not communicated on time.

Wear and Tear Issues

Most of the stakeholders stated that the logger provided to them runs only on 3G SIM and most of the good network providers provide only 4G SIMs. Further, lack of proper guidelines for equipment management, theft and loss of mobile or equipment parts, float assembly and repairs and replacement of equipment. It was also noted that middle aged staff had problems with the small size of the screen on the phone.

4

ECONOMIC ASSESSMENT

4.1 Economic Assessment

Saving/dissaving Related to Vaccines Utilization, pre- and post-eVIN Implementation (Using Utilization Data Obtained from the Ministry)

Utilization data provided by the immunization division (Figure 17 & 18) of the ministry was considered to present saving/dissaving related to all vaccines during pre- and post-eVIN period. Because of time and budget constraint, the data could not be collected from the representative samples of cold chain points from all the 12 states for economic assessment. Hence, utilization data from ministry was collected to get a complete picture of saving / dissaving related to vaccines in all eVIN states. The saving / dissaving utilization data is presented in Table 26. The highest saving is for pentavalent vaccine in all eVIN states (INR 54 crore). This was expected as pentavalent was the most expensive vaccine as compared to the other vaccines used in the calculation. The net saving in Rajasthan was INR 2.02 crore and in Odisha was INR 2.97 crore.

Table 26: Saving/dissaving related to vaccine stock at the state vaccine stores (INR Crore) using utilization data

States / Vaccines	BCG	OPV	Hep-B	Pentavalent	Measles	DPT	TT
Assam	0.18	2.12	--	5.05	1.00	0.11	0.30
Bihar	0.60	2.83	0.22	22.28	3.30	0.59	0.40
Chhattisgarh	0.22	1.31	-0.04	3.26	0.36	0.00	0.02
Gujarat	-0.05	0.53	-0.11	0.65	0.95	0.30	-0.24
Himachal Pradesh	0.01	0.91	0.03	0.26	0.30	-0.01	0.02
Jharkhand	-0.27	0.38	--	1.29	1.22	0.61	0.04
Madhya Pradesh	0.36	1.79	-0.03	5.75	-0.28	-1.18	-0.10
Manipur	0.01	0.04	0.02	0.18	0.05	0.02	0.01
Nagaland	0.00	0.00	0.00	0.09	0.07	0.00	-0.01
Odisha	-0.02	1.23	-0.05	1.23	-0.02	0.50	0.11
Rajasthan	0.06	-3.00	-0.09	6.96	-1.60	-0.29	-0.02
Uttar Pradesh	1.80	--	12.52	7.01	6.00	0.60	4.83
Total	**2.89**	**8.14**	**12.46**	**54.02**	**11.35**	**1.25**	**5.37**

Note: The blanks indicate that because of discrepancy in data, the analysis did not consider this information

Savings from Prevention of Vaccine Wastage

The projected number of vaccines being discarded in the year for all the 12 eVIN states, are presented in Table 27. For return on investment estimations, savings due to reduction in discard of vaccine were calculated based on the findings of programmatic assessment. The maximum savings have been recorded for DPT vaccines. Total 10,37,637 doses were saved from seven assessed vaccines.Total amount saved based on this analysis was INR 0.58 crores.

Table 27: Antigen wise doses of vaccines discarded in pre eVIN versus post eVIN period

State	Pre-eVIN	Post-eVIN	% reduction in doses discarded
BCG	128,751	25,750	80.0
DPT	801,670	10,668	98.7
HEP-B	64,209	33,442	47.9
MEASLES	34,278	6,688	80.5
OPV	192,626	150,489	21.9

PENTA	29,094	16,387	43.7
TT	37,121	6,688	82.0
Total	**12,87,749**	**2,50,112**	**80.6**

Savings from Missed Opportunity

The projected number of sessions missed due to stock-out of vaccines, and the number of children missed from vaccination are presented in Table 28. The numbers have been projected for a year for the all 12 eVIN states. The projections suggested that after eVIN implementation, an additional 401,438 beneficiaries were administered with the due antigen.

Table 28: Number of sessions missed and the number of children missed due to stock-out of vaccines

Antigen	Sessions missed		Missed opportunity*	
	Pre-eVIN (2015-16)	Post-eVIN (2017-18)	Pre-eVIN (2015-16)	Post-eVIN (2017-18)
BCG	28,253	31,378	57,086	58,030
HEP-B#	37,256	29,578	37,813	34,091
OPV	43,744	28,127	380,095	232,632
DPT	51,569	101,257	193,977	162,935
PENTA	52,856	10,912	198,095	59,107
MEASLES	47,000	31,434	163,454	103,300
TT$	17,697	15,152	101,850	80,837
Total	**2,78,37 5**	**2,47,838**	**11,32,370**	**7,30,932**

**Missed opportunity has been calculated by number of sessions missed, multiplied by number of children/women immunized/session in the pre/post period from the HMIS data for the 12 eVIN states.*

#Hep-B is in number of days of stock-out instead of number of sessions. To calculate missed opportunity, number of days of stock-out was multiplied with the number of children immunized with Hep-B in a facility in a day in the pre/post period from HMIS data for 12 eVIN states.

$includes pregnant women as well.

The highest impact of missed opportunity was on OPV and pentavalent vaccine. In case of OPV, 147,463 additional children were at risk of the disease in the pre-eVIN period while 138,988 additional children were at risk for diseases related to pentavalent vaccine. Assuming an annual incidence rate of polio 15 per 100,000 children [16], it was estimated that 22 additional children were at risk of polio in the pre-eVIN period. The incidence rates for childhood Hib pneumonia and meningitis were assumed 1,102 per 100,000 children and 22 per 100,000 children respectively [17].

It was estimated that 1,532 additional children were at risk of Hib pneumonia in the pre-eVIN period and 31 additional children were at risk of meningitis in the post-eVIN period. Based on the literature review, it was assumed that 70% of those affected by the disease will have treatment access and the distribution of access across various levels was calculated from Clark et al (2013) where the study also assumed that the incidence of hospital admission will be 55 per 100,000 per year. The assumptions on treatment access and unit cost of outpatient visit and inpatient stay is presented in Table 29.

Table 30 presents the estimated outpatient visit cost and inpatient stay cost for the additional children who are at risk of the disease in the pre-eVIN period. The cost of outpatient visit and hospitalization were obtained from Clark et al (2013). The study reported data for 2010 in USD$ and all the figures were converted into 2018 Indian rupee

(INR) using consumer price index. From childhood Hib pneumonia and meningitis, INR 747,720 is the estimated savings from these 12 states. As mentioned earlier, cost of illness information was not available for most of the vaccine preventable diseases in the Indian context. Hence, the study was unable to calculate the cost saving from other vaccine preventable diseases.

Table 29: Access to health care and unit cost of medical services (2018, in INR)

	Access to health care (%)	Hospitalization		OPD visit	
		Meningitis	Pneumonia	Meningitis	Pneumonia
Private hospital	50%	40,123	24,826	376	376
Primary hospital	23%	35,483	21,315	125	125
Secondary hospital	26%	36,361	21,942	878	878
Tertiary hospital	1%	62,566	37,239	1,129	1,129

Source: Clark AD et al (2013). Impact and cost-effectiveness of Haemophilus influenza Type b conjugate vaccination in India. J Pediatr, 163 (1 Suppl): S60-S72.

Table 30: Cost saving from Hib pneumonia and meningitis using missed opportunity data from 12 eVIN states

	Pneumonia	Meningitis
Cases averted	1,532	31
Access to health care	70%	70%
Cases accessed health care	1072	22
OPD visit require per case	1	1
Cost of OPD visit in private hospital	288,016	5,828
Cost of OPD visit in primary hospital	44,045	891
Cost of OPD visit in secondary hospital	349,725	7,077
Cost of OPD visit in tertiary hospital	17,296	350
Cost of hospitalization in private hospital	33,808	684
Total cost saved from cost of illness	**732,890**	**14,830**
Total cost saved from both diseases	**747,720**	

Note: Total amount saved from cost of illness includes total OPD visit cost and cost of hospitalization

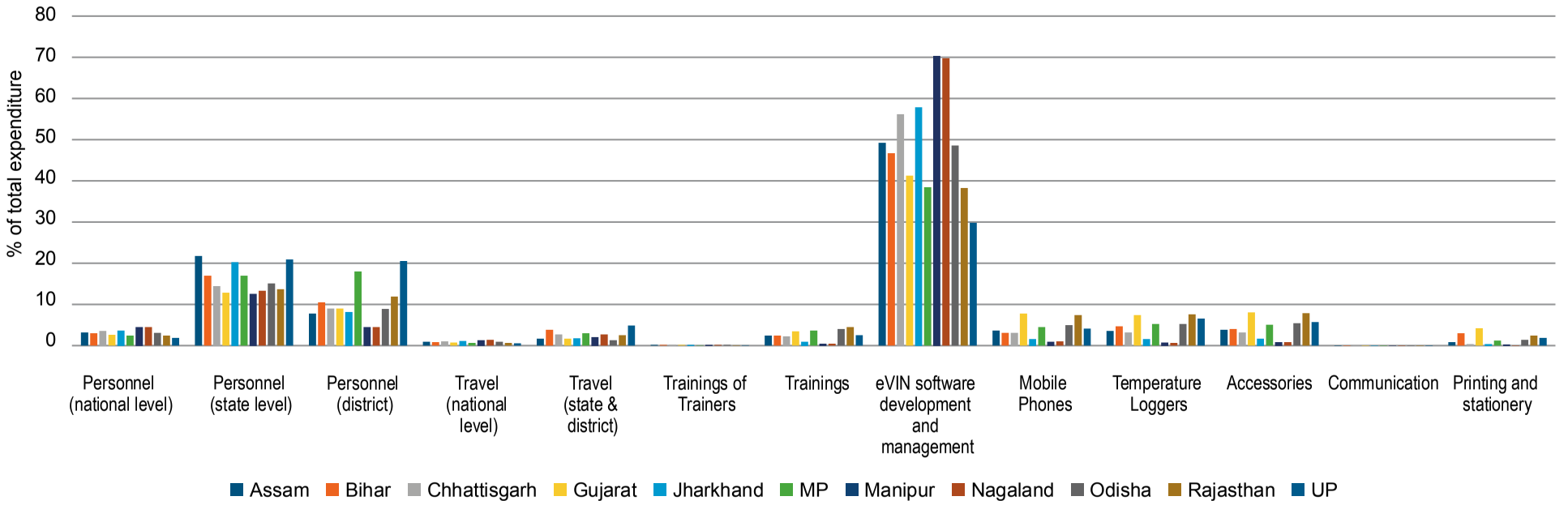
4.2 Investment Related to eVIN

Total investment related to eVIN was calculated during the period of 2014 to 2017. The data was obtained from the finance division of UNDP. Apart from the state-wise investment data for 11 eVIN states (there was no expenditure for Himachal Pradesh during 2014-17), the national level expenditure was also received, which included costs for eVIN software development and maintenance, development of communication materials, expenditure related to national level staff etc. National level expenditure was equally distributed across all 12 states. Total expenditure related to eVIN in 11 states is presented in Table 31 and the proportion of different components is presented in Figure 42. The highest expenditure in eVIN was seen in Uttar Pradesh (INR 259 million), followed by Rajasthan (INR 202 million) and Madhya Pradesh (INR 201 million). The lowest investment was in Manipur (INR 110 million) followed by Nagaland (INR 111 million) and Jharkhand (INR 133 million).The highest amount was spent on eVIN software development and it varied from 30% of total investment in UP to 70% of total investment in Manipur (Figure 42). The next important investment was on state level personnel and this contributed to about 13% of total investment in Manipur and about 22% in Assam.

Table 31: Total expenditure on eVIN during 2014-2017 (INR million)

States/ components	Personnel (national level)	Personnel (state level)	Personnel (district)	Travel (national level)	Travel (state and district)	Training of trainers	Trainings	eVIN software development and management	Mobile Phones	Temperature Loggers	Accessories	Communication	Printing and stationery	Total
Assam	5.02	34.26	12.36	1.55	2.72	0.31	3.91	77.25	5.90	5.78	6.18	0.06	1.48	156.78
Bihar	5.02	28.25	17.39	1.55	6.53	0.31	4.19	77.25	5.11	7.72	6.81	0.06	5.09	165.27
Chhattisgarh	5.02	19.90	12.36	1.55	3.83	0.31	3.17	77.25	4.28	4.39	4.58	0.06	0.70	137.40
Gujarat	5.02	24.18	16.93	1.55	3.28	0.31	6.62	77.25	14.77	13.98	15.19	0.06	7.95	187.09
Jharkhand	5.02	27.11	10.98	1.55	2.51	0.31	1.40	77.25	2.15	2.22	2.31	0.06	0.66	133.53
MP	5.02	34.26	36.17	1.55	6.13	0.31	7.55	77.25	9.01	10.65	10.41	0.06	2.46	200.83
Manipur	5.02	13.89	5.03	1.55	2.42	0.31	0.65	77.25	1.11	0.89	1.06	0.06	0.45	109.69
Nagaland	5.02	14.76	5.03	1.55	3.02	0.31	0.65	77.25	1.17	0.81	1.05	0.06	0.03	110.71
Odisha	5.02	24.02	14.19	1.55	2.13	0.31	6.52	77.25	8.11	8.53	8.80	0.06	2.31	158.80
Rajasthan	5.02	27.87	24.11	1.55	5.16	0.31	9.13	77.25	14.99	15.29	16.01	0.06	5.13	201.89
UP	5.02	54.11	53.19	1.55	12.82	0.31	6.71	77.25	10.78	17.26	14.89	0.06	4.98	258.93
Total	**55.24**	**302.61**	**207.74**	**17.02**	**50.54**	**3.44**	**50.51**	**849.73**	**77.40**	**87.52**	**87.28**	**0.68**	**31.23**	**1820.91**

Figure 42: Contribution of different components in total expenditure



Time Spent by Different Categories of Staff Related to eVIN

Staff members at the CCPs spent time on training and meetings related to eVIN, vaccine transport handling and record keeping and entering utilization data in mobile phones for eVIN. In order to understand the time spent by different categories of staff, staff members were interviewed in each CCP visited in 7 states for eVIN economic assessment. The information gathered from sampled 102 CCPs was extrapolated for all CCPs in 12 eVIN states. The training pattern followed across all states was similar; two cold chain handlers from each CCP were trained for two days and also included the training of all district immunization officers. Information was also gathered on the hours spent for training by different categories of staff and multiplied the same by the salary per hour of those staff. Total human resources cost for training related to eVIN was estimated at INR 6.24 crores. The highest HR cost for training was found in Rajasthan (INR 1.35 crore) followed by Gujarat (INR 1.91 crore) and Uttar Pradesh (INR 0.76 crore) (not reported in table). The high costing in Rajasthan was attributed to the high numbers of CCPs in the state; Rajasthan had the highest numbers of CCPs among the 12 states. A mention is recorded here that the hours spent has been calculated for the cold chain handlers at the CCPs and not for the staff appointed by UNDP for eVIN. Their salaries were included in investment from eVIN.

The number of trips required for vaccine collection from higher CCPs was also estimated in the pre- and post-eVIN period. If the number of trips was less during the post-eVIN period, it was assumed there will be some cost savings in terms of travel time for vaccine collection, vaccine handling, record keeping as well as fuel cost. However, the data from 102 CCPs showed that on the whole more number of trips was required for vaccine collection in the post-eVIN period. The number of trips required for vaccine collection is given in Table 32. Excluding Chhattisgarh, all other states had higher number of trips during post-eVIN period, hence, this component was not considered in return on investment calculation as there was no savings related to this particular component.

On an average, each CCH spent 10 minutes per session day to calculate the utilization of different vaccines and data entry using the eVIN entry format in their mobile phones. Data was collected for the number of sessions held during 2017-18 from HMIS, multiplied the number by minutes spent per session day to get the total hours spent in one year for eVIN mobile entry. The hours spent was then multiplied by the salary per hour to estimate the HR cost related to eVIN entry. Total HR cost related to eVIN entry was estimated at INR 16.29 crore, Uttar Pradesh had the highest cost (INR 5.44 crore) because of the maximum number of sessions held among all other eVIN states, followed by INR 2.56 crore in Bihar and INR 2.18 crore in Madhya Pradesh (not reported in Table).

Table 32: Number of trips required for vaccine collection in the pre- and post-eVIN period

States	Sampled CCPs	Number of trips	
		Pre- eVIN	Post-eVIN
Assam	19	1,637	1,787
Chhattisgarh	12	906	797
Gujarat	15	1,049	1,221
Jharkhand	11	1,033	1,148
Nagaland	6*	282	449
Odisha	20	1,543	1,565
Rajasthan	18	684	756

**Data not available from 2 CCPs*

4.3 Return on Investment Related to eVIN

Return on Investment was calculated using both the financial cost and economic cost approach and using the data collected for eVIN economic assessment and utilization data as the source. Return on Investment is defined as

the amount of return (in terms of money) obtained by investing one unit of money in any programme or activity. Total return includes the sum of net savings from all aspects due to eVIN and the total investment is the sum of all expenditures related to eVIN. Return on Investment using utilization data with assessed vaccines including new vaccines cost is presented in Tables 33 and Table 34.

Table 33: Return on Investment based on utilization data for assessed vaccines

	Net saving (INR crore)	Investment (INR crore)	ROI
Assam	8.76	15.68	0.56
Bihar	30.23	16.53	1.83
Chhattisgarh	5.13	13.74	0.37
Gujarat	2.04	18.71	0.11
Jharkhand	3.28	13.35	0.25
Madhya Pradesh	6.31	20.08	0.31
Manipur	0.34	10.97	0.03
Nagaland	0.15	11.07	0.01
Odisha	2.97	15.88	0.19
Rajasthan	2.02	20.19	0.10
Uttar Pradesh	32.76	25.89	1.27
Total	**94.09**	**182.09**	**0.52**

Table 34: Return on Investment based on utilization data (including all vaccines- both assessed and new vaccines)

	Investment (INR crore)	Net saving (INR crore) for assessed vaccines)	Saving from new vaccine* (INR crore)	Total saving (all vaccines utilization+ discard vaccines+ missed opportunity cost)	ROI
Assam	15.68	8.76	6.91	15.67	1.00
Bihar	16.53	30.23	27.74	57.96	3.51
Chhattisgarh	13.74	5.13	6.04	11.17	0.81
Gujarat	18.71	2.04	12.62	14.66	0.78
Jharkhand	13.35	3.28	8.00	11.27	0.84
Madhya Pradesh	20.08	6.31	18.96	25.27	1.26
Manipur	10.97	0.34	0.43	0.77	0.07
Nagaland	11.07	0.15	0.30	0.45	0.04
Odisha	15.88	2.97	7.93	10.90	0.69
Rajasthan	20.19	2.02	17.46	19.48	0.96
Uttar Pradesh	25.89	32.76	55.36	88.13	3.40
Total	**182.09**	**94.09**	**161.75**	**255.84#**	**1.41**

**also include savings from wastage and missed opportunity*

**new vaccines include rotavirus, IPV, PCV and MR and 80% coverage assumed*

#includes cost saving form Hib pneumonia and meningitis

For all 11 states taken together (excluding Himachal Pradesh), total investment related to eVIN was estimated to be INR 182 crore using utilization data of all vaccines including new vaccines introduced post eVIN introduction

and total benefits (including net savings from stock position, doses discarded during pre- and post-eVIN period and savings due to reduction in missed opportunities) was estimated to be INR 255.84crores resulting in a ROI of 1.41. Given the investment of INR 182 crore, it is assumed that one-rupee investment in eVIN will lead to a return of INR 1.41.

Results show that the highest return on eVIN investment was from Bihar where one-rupee investment in eVIN gave INR 3.51 return, the second highest return was from Uttar Pradesh (one-rupee investment gave a return of INR 3.40). Madhya Pradesh and Assam also showed the positive return of investment along with Uttar Pradesh and Bihar. Lowest ROI was from smaller states such as Manipur (0.07) and Nagaland (0.04).

4.4 Future Projections on ROI

Few activities related to eVIN were considered as start-up activities, for example training of trainers, training of staff etc. as there is an assumption that the state level staff of the 12 states will not always be part of implementation in the future. Additionally if an assumption is made that half of the mobile phones, temperature loggers and accessories will need replacement every year, and the personnel at the national level will require to spend only half of their time in eVIN, then the investment in eVIN is estimated to reduce in the future. An estimation is made that the recurrent expenditure on eVIN in 11 states for the next few years will be approximately INR 88 crore. If the same assumption of saving is accepted in the future, then the return of investment in the future can be estimated to be INR 2.91 for each one-rupee invested at the national level (Table 35). The analysis further shows that one-rupee investment in eVIN will give more than six times the return in UP and Bihar. As the programme progresses, it is suggested seven more states will also have a positive return from eVIN. Furthermore, it is suggested that two states: Manipur and Nagaland will not have a positive ROI owning the reasons to the population size of these two states

Table 35: Future saving including new vaccines and investment (INR Crore)

States	Net saving from assessed vaccines	Saving from new vaccines*	Total saving	Investments (removing onetime costs)	ROI
Assam	8.76	6.91	15.67	6.66	2.35
Bihar	30.23	27.74	57.96	9.00	6.44
Chhattisgarh	5.13	6.04	11.17	6.46	1.73
Gujarat	2.04	12.62	14.66	9.13	1.61
Jharkhand	3.28	8.00	11.27	5.86	1.92
MP	6.31	18.96	25.27	10.09	2.50
Manipur	0.34	0.43	0.77	5.06	0.15
Nagaland	0.15	0.30	0.45	5.07	0.09
Odisha	2.97	7.93	10.90	7.25	1.50
Rajasthan	2.02	17.46	19.48	9.87	1.97
UP	32.76	55.36	88.13	13.36	6.60
Total	**94.09**	**161.75**	**255.84#**	**87.81**	**2.91**

**new vaccines include rotavirus, IPV, PCV and MR and 80% coverage assumed*

#includes cost saving form Hib pneumonia and meningitis

Total net saving included saving / dissaving from stock positions of vaccines and savings from reduction of wastage rates of vaccines and savings from missed opportunity. As there was no state-wise missed opportunity and wastage data, only two components were added with total net saving.

4.5 Estimated Cost of Scaling up of eVIN

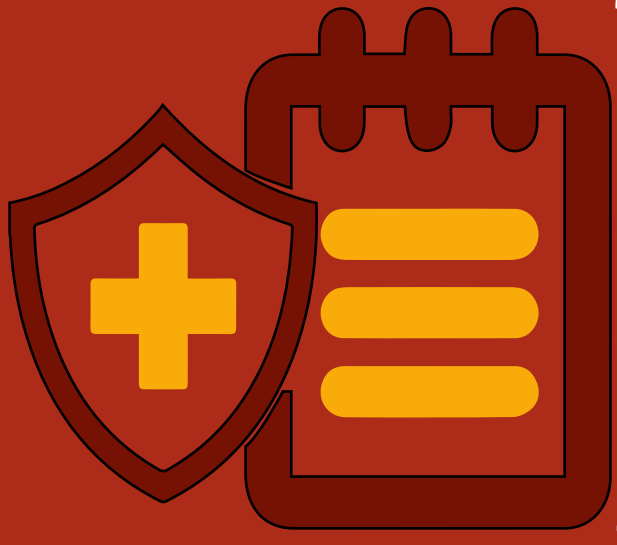
Currently eVIN is been implemented in 12 states and an estimation was made on the amount of investment required for scale up. It is assumed that some fixed expenditures will be similar across states, e.g. eVIN software development and management, training of trainers, communication materials and personnel at the national level for supervising all activities. Based on the UNDP expenditure data, an estimated investment is suggested to be about INR 8.42 crore per state for a period of three years. It is expected that in any state, the implementation will be in a phased manner and the expenditure to incur will be gradual over a period of 2-3 years. The operational expenditure for mobile phones, temperature loggers, printing and stationery, accessories, and trainings depend on the number of cold chain points of the respective states. Based on the expenditure pattern of 12 states, it is estimated the average amount required per cold chain point to be INR 36,087 (ranging from INR 27,731 to INR 47,720with a mention that it is a financial cost, does not include the time cost required to implement the programme.With regard to human resources costs, this was not calculated as the government pay scale will be different than the figures received from UNDP. Further, it is expected that the existing cold chain handlers at cold chain points will be managing the system also in the future and there will probably be no additional hiring of staff for eVIN implementation.

Conclusion

In the analysis, the total investment and total benefit related to eVIN in 11 states was estimated. Himachal Pradesh was excluded from this analysis due to the lack of investment in the state during the period of 2014-2017. Investments were made at the national level which included the development of eVIN software and its maintenance, communication materials, national level staff salary, and travel etc. and at the state level, expenditure on purchasing of mobile phones, temperature loggers, and accessories, personnel at the state and district level. Benefits of eVIN were calculated using utilization data from pre- and post-eVIN period. The return on investment was calculated using the investment and benefit data from 11 states. Bihar and Uttar Pradesh showed higher return than investment when calculating benefits. Considering scale up in the future, it is suggested that some of these expenses will reduce and eVIN will be a better investment whereon-rupee investment will lead to an estimated INR 2.91 return from eVIN at the national level (considering 11 states data after adding the new vaccines rotavirus, IPV, PCV and MR in this calculation, considering 80% coverage of all these vaccines and applying the average saving from other vaccines). eVIN will give more benefit in the future when all the vaccines will be considered minus the start-up investment.

With the implementation of eVIN, there has been clear visibility of vaccine stock position, better OPV management during the tOPV to bOPV switch; earlier distribution of several near to expiry DPT vaccines for better utilization and effective temperature alerts resulted in swift remedial actions in saving vaccines from early expiry. All these instances will lead to improved and positive cost implications and cost saving modalities; however, this could not be quantified and validated in the assessment due to unavailability of pre-eVIN period data on the same.

The ROI analysis was carried out using the government perspective, hence, only the cost of illness that was averted as a result of missed opportunity was considered and the amount of saving was found not to be significant with only a few reasons of low-cost saving from missed opportunity: firstly, the cost of illness information was not available in the Indian context for many vaccine preventable diseases, secondly, government perspective for the economic assessment was considered as the basis, and not the societal perspective which would have also included savings from productivity loss and premature mortality etc. If the cost of illness that can be saved by avoiding diphtheria, tetanus, pertussis, measles etc., was included, the estimation of saving would be much higher; and the savings from productivity loss and premature mortality and the benefits from eVIN implementation will be overall much higher.



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RECOMMENDATIONS

Recommendations

Cold chain management for vaccines in public health system is always associated with many challenges. Addressing these challenges require a lot of efforts by key stakeholders across the vaccine supply chain such as GMSD, SVS, RVS, DVS, CCPs and the MoHFW at large.

eVIN system is playing a pivotal role in effective and efficient management of vaccine supply, supervision and monitoring. The findings of this assessment suggest significant positive changes in the areas of vaccine stock management, wastage, utilization and documentation. To have an effective and efficient eVIN system, following are the recommendations and actions that are suggested and these have been derived after utilizing key findings, major challenges and bottlenecks:

1. Human Resource and Training

The cold chain handlers are the backbone of vaccine supply chain, even though CCH is not a designated post in the country. At most of the facilities (67%), either ANMs or health supervisors have been given the charge of CCH across 12 eVIN states. Noticeably in Gujarat, 96% CCH are pharmacists. Further, given the fact that over 39% of CCHs are 50 years of age or above, and are nearing retirement, states need to develop detailed human resource plan for building a fleet of CCHs for their replacement in the future. Moreover, an additional person will need to be trained in cold chain management to serve as a back-up CCH in case of non-availability of primary CCH.

Routine transfers of personnel working as CCHs are a key concern for cold chain management. Since a lot of effort and investment goes into training a person to work as CCH and the function of vaccine and cold chain management is highly critical, states should take due steps to ensure the trained cold chain handlers are not transferred frequently and are able to work in the same role and any replacement should be with a trained handler only.

2. Vaccine Stock Management

Overall, facilities observing stock-out of any vaccine have significantly reduced after eVIN introduction. But the instances of minimum and maximum stock remained unimproved. Even after reduction in stock-out, 26.3% facilities still observed stock-out in the post-eVIN phase. Though, there can be several underlying factors affecting the stock-out situation, like variable vaccine distribution and variable indenting processes at various levels among others. The current system of eVIN does not include procurement and distribution process at the national level and it is highly recommended to include the procurement in the existing eVIN system.

The variable mechanism in vaccine distribution may also be affecting stock-outs. The vaccines are being pushed or pulled irregularly on weekly or monthly basis and often depending on the need of the facilities. There is a need for strict guidelines to standardize and uniformity across the states to either to follow push or pull mechanism unanimously on a timely basis.

eVIN serves as an evidence based decision-making tool for forecasting requirements and managing stocks. However, there is still some human resource gap in terms of not being able to use all the features of eVIN dashboard for vaccine stock management. Capacity of CCHs should be strengthened to optimally use the eVIN dashboard for maintaining stocks.

Further, quantum of vaccines needed at each CCP is determined based on estimated target population. These estimates of target population were drawn several years back and it is imperative that this exercise be conducted on a regular basis to reach realistic estimates of the target population thus leading to actual requirement of vaccines at each CCP. Systems can be built in eVIN technology to give realistic estimates based on consumption trends including buffer stock.

3. Wastage

Vaccine wastage is usually not recorded and reported due to the fear of disciplinary action. A proper system should be put in place to monitor and review wastage of vaccines and staff should be encouraged to report wastage along with the related cause in an enabling environment.

UNDP data was relied upon to understand the vaccine wastage pattern and it was observed that post-eVIN vaccine wastage has declined for most states, except for Assam, Chhattisgarh, Gujarat and Himachal Pradesh. Capacity building of cold chain staff and nurses in area of vaccine handling and administration and close supervision are recommended to bring down vaccine wastage in these states.

Currently, eVIN application captures the number of vials issued to the ANMs but it does not capture the number of beneficiaries who were vaccinated. Incorporating this feature in eVIN software will further help improve stock management and keep a check on vaccine wastage at the user level.

4. Vaccine Distribution Practices

Vaccines are supplied as per demand and no significant changes have been observed in order fill rate across all eVIN states. Hence, universal use of order management is recommended. Lateral sharing of vaccine stock shows decrease in post-eVIN period across states. Clear guidelines need to be issued to discourage lateral sharing of vaccines across the vaccine supply chain management.

In-depth interviews with majority of the stakeholders concluded that going to vaccine stores multiple times in a month to fetch antigens is a big challenge. Instead of pull system it is recommended to have push system from DVS while supplying vaccines to CCPs with a scheduled route plan. This will only help in saving time, cost of petrol, oil and lubricant (POL) and breakage while transportation.

5. Vaccine Management Practices

Temperature log book and indent forms were incomplete in around 1/3rd of facilities across eVIN states. Mentoring, closed supervision and periodic physical inspections of records are recommended to improve record keeping practices.

6. Temperature Monitoring

Proper temperature monitoring is a key to proper cold chain management. In addition to the cold chain handler, who holds the primary responsibility for maintaining temperature logs, another back-up person should also be trained to monitor and record the temperature in absence of primary CCH.

Instances of temperature excursions and breaches were found due to improper positioning of stem thermometer at many facilities during the assessment. It is important to ensure that stem thermometers are positioned in a central location in the storage unit, adjacent to the vaccine.

Vaccines are moved to alternate temporary storage refrigerator during defrosting or cleaning. In such events, temperature of alternate storage and/or pre-cooler insulated container with ice packs should also be monitored.

7. Technology

Most of the stakeholders stated that the logger provided to them run only on 3G SIM and most of the good network providers provide only 4G SIMs. Poor connectivity in hard-to-reach areas hinders real-time temperature monitoring. Therefore, it is recommended to have wi-fi data loggers with better data and network connectivity.

8. Dual Record-keeping

Dual record-keeping is a time-consuming process across eVIN states. CCHs in eVIN states are maintaining physical records as well as are updating eVIN system. It is recommended that dual record keeping system should only continue until the countrywide expansion of eVIN system. Once the eVIN system is fully operational across the country, print-outs from the eVIN can replace the vaccine stock register and stock registers may gradually be withdrawn. Data security mechanisms and system in place need high level of commitment and further strengthening across the supply chain.

9. Wear & Tear of Mobiles and Data Loggers

It is recommended to provide guidelines for float assembly for data loggers, theft, loss and maintenance of smartphones due to a shelf life of 2-3 years only.

10. Monthly Review of Dashboards

The nine performance indicators of eVIN dashboards are not fully utilized at the district level. It is recommended to include review of dashboard in the district level monthly meetings to keep a track on performances. To facilitate standardization and sense of commitment and competition, star rating of CCPs may be considered.

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ANNEXURE

Annexure 1

District-wise Details of pre-eVIN period

Reference period (pre-eVIN)			
S. No.	**State**	**District**	**Reference period**
1	Assam	Dhubri	Apr 16 to Sep 16
	Assam	Jorhat	Apr 16 to Sep 16
	Assam	Nagaon	Apr 15 to Sep 15
2	Bihar	Jamui	Oct 15 to Mar 16
	Bihar	Nalanda	Apr 16 to Sep 16
	Bihar	Patna	Oct 15 to Mar 16
	Bihar	Lakhisarai	Oct 15 to Mar 16
3	Chattisgarh	Balod	Apr 16 to Sep 16
	Chattisgarh	Dhamtari	Apr 16 to Sep 16
	Chattisgarh	Kawardha	Apr 16 to Sep 16
4	Gujarat	Panchmahal	Oct 15 to Mar 16
	Gujarat	Kheda	Oct 15 to Mar 16
	Gujrat	Porbandar	Oct 15 to Mar 16
5	Himachal Pradesh	Shimla	Oct 16 to Mar 16
6	Jharkhand	Dhanbad	Apr 16 to Sep 16
	Jharkhand	Dumka	Apr 16 to Sep 16
7	Madhya Pradesh	Alirajpur	Apr 15 to Sep 15
	Madhya Pradesh	Betul	Apr 15 to Sep 15
	Madhya Pradesh	Chhindwara	Oct 15 to Mar 15
	Madhya Pradesh	Hoshangabad	Apr 15 to Sep 15
	Madhya Pradesh	Vidisha	Apr 15 to Sep 15
8	Manipur	Imphal West	Apr 16 to Sep 16
9	Nagaland	Kohima	Apr 16 to Sep 16
10	Odisha	Balasore	Oct 15 to Mar 15
	Odisha	Jajpur	Apr 16 to Sep 16
	Odisha	Nuapada	Oct 15 to Sep 15
11	Rajasthan	Bharatpur	Apr 15 to Sep 15
	Rajasthan	Bikaner	Oct 11 to Mar 11
	Rajasthan	Chittorgarh	Apr 16 to Sep 16
12	Uttar Pradesh	Basti	Apr 15 to Sep 15
	Uttar Pradesh	Ghaziabad	Apr 15 to Sep 15
	Uttar Pradesh	Gorakhpur	Apr 15 to Sep 15
	Uttar Pradesh	Kushinagar	Apr 15 to Sep 15
	Uttar Pradesh	Shahjahnpur	Apr 15 to Sep 15
	Uttar Pradesh	Shravasti	Oct 15 to Mar 16
	Uttar Pradesh	Unnao	Apr 15 to Sep 15
	Uttar Pradesh	Varanasi	Apr 15 to Sep 15

Annexure 2

Training Details

eVIN			
State Name	**No. of CCP**	**CCHs Trained on VCCH Modules (%)**	**CCHs Trained on eVIN (%)**
Manipur	6	67	82
Himachl Pradesh	23	70	96
Uttar Pradesh	66	85	91
Madhya Pradesh	68	85	88
Assam	44	91	95
Rajasthan	132	91	91
Jharkhand	13	92	100
Gujarat	120	93	96
Bihar	37	95	100
Odisha	71	97	96
Chattisgarh	31	100	100
Nagaland	6	100	100
Total	**617**	**90**	**94**

Non-eVIN		
State Name	**No. of CCP**	**No. of CCHs Trained on VCCH Modules**
West Bengal	90	82
Punjab	78	45
Haryana	60	43
Total	**228**	**170**

Designation Details

eVIN (in numbers)					
State Name	**ANM**	**Health Supervisor Male**	**Health Supervisor Female**	**Pharmacist Others**	**Others**
Assam	37	1	6	0	0
Bihar	18	5	1	1	12
Chattisgarh	4	2	15	3	7
Gujarat	6	0	7	106	1
Himachal Pradesh	4	8	11	0	0
Jharkhand	6	0	0	0	7
Madhya Pradesh	4	28	9	18	9
Manipur	2	0	3	0	1
Nagaland	3	0	0	1	2
Odisha	16	6	47	0	2
Rajasthan	37	15	72	8	0
Uttar Pradesh	6	25	10	5	20
Total	**143**	**90**	**181**	**142**	**61**

Non-eVIN (in numbers)					
State Name	**Pharmacist**	**ANM**	**Others**	**Health Supervisor Female**	**Health Supervisor Male**
West Bengal	7	41	22	15	3
Punjab	4	68	0	4	0
Haryana	18	35	4	1	0
Total	**29**	**144**	**26**	**20**	**3**

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