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RESEARCH ARTICLE

A STUDY ON THE INVENTORY MANAGEMENT OF RAPID ANTIGEN KITS TO ENSURE CONTINUOUS SUPPLY CHAIN MANAGEMENT AT THE POINT OF COVID-19 SERVICE WITH EFFICIENT COST CONTROL AT TSMSIDC, DEPARTMENT OF HEALTH, MEDICAL AND FAMILY WELFARE, GOVERNMENT OF TELANGANA

K. Chandrasekhar Reddy[1] and Dr. V. Rambabu Naik[2]

1. Managing Director, TSMSIDC, Hyderabad, Telangana.
2. Special Officer, TSMSIDC, Hyderabad, Telangana.

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Abstract

One of the responsibilities of TSMSIDC, Govt. of Telangana is procuring drugs, diagnostics, reagents, and consumables, and supply them to various health facilities across the state. During the COVID-19 period, TSMSIDC has taken up the onus of procuring testing kits and COVID-19-specific medicines as well. The objective of the paper is to present the different inventory management and supply chain management strategies (deployed) by TSMSIDC to optimize the expenditure incurred towards purchasing of Rapid Antigen Testing Kits (RAT). This is also intended to present how TSMSIDC was able to **save over Rs. 58 Crores** during this period adopting different strategies to save the cost, while maintaining the quality and standards of the kits purchased.

Introduction:-

Telangana State Medical Services Infrastructure Development Corporation (TSMSIDC) is an autonomous body under the control of the Govt of Telangana. TSMSIDC was established on August 28, 2014, wide GO MS no 14 HM & FW(C2) after the bifurcation of Andhra Pradesh State.

TSMSIDC's main role is to procure the equipment, drugs, diagnostics, reagents, consumables, and civil works on the E-tender platform and the GeM platform based on the needs and expectations of TSMSIDC customers, such as (National Rural Health Mission [MD-NHM], Department of Public Health and Family Welfare [DOPH], Directorate of Medical Education [DME] and commissioner Telangana Vidya Vidhana Parishad [TVVP]) and also maintaining an integrated health dashboard, works monitoring system, E-Aushadhi,E-Hospital Management System, that is useful for all public health secondary and Teaching health care facilities of Telangana state.

Aim:-

To plan, design, and implement an effective, and efficient inventory control and supply chain management system at TSMSIDC to optimize cost control without compromising on the quality and standards as per market trends.

Objectives:-

1. To reduce the financial expenditure on inventories.

Corresponding Author:- K. Chandrasekhar Reddy
Address:- Managing Director, TSMSIDC, Hyderabad, Telangana.

2. To minimize the ideal time by avoiding stock shortages at all times
3. To avoid losses from Inventory obsolescence.
4. To improve the quality of standards of care while adhering to ICMR guidelines at every step

Literature Review:-

Inventory:
According to Webster, Inventory can be defined as the quantity of goods (or) materials on hand.

Inventory Control:
Inventory control is a mechanism that is leveraged to maintain an economic minimum investment in materials and products intended for obtaining a maximum financial return in the inventory control system, achieved by fixing a minimum and maximum for each item. The item procurement mechanism in designed such that the stock level at any time, never goes beyond the minimum level fixed for it. The inventory needs to be managed efficiently for various reasons, some of them are:

1. For efficient and effective management of demand
2. To avoid a stock–out situation
3. To ensure a smooth distribution cycle
4. To seek protection from price increments in the short-term
5. For the smooth running of the business

Lead Time:
It is the average duration of time in days between the placing of an order and the receipt of materials. When determining the quantity of any item to be ordered, we must take into consideration the "Lead time" so that orders can be placed at a time when the existing stocks are sufficient for the needs of the hospital during the lead time. The lead time to procuring any item can be divided into two parts, namely:

Internal Lead Time (I.L.T):
Internal lead time is the time required for organizational formalities to be completed. In the TSMSIDC case, lead time can be considered as, placement of requisition from the user department to the procurement department, tender notification, tender opening, etc.

External Lead time (E.L.T):
External lead time is the time taken in the placement of order and receipt of goods.

The total lead time can be computed by working out the time taken in internal and external procurement processes. It is a common belief that external lead time should be reduced, but in actual practice, the internal lead time constitutes a considerable part of total lead time and offers ample scope for optimization. The internal lead time is within the preview of the Administration. By streamlining the procedures and reducing red-tapism, this can usually be reduced by at least 50 percent. The external lead time cannot be avoided but it may be minimized by:

1. Timely reminders and follow-ups
2. Judicious expediting
3. Maintaining good relations with the suppliers
4. Penalty for delayed supplies

Safety stock level:
If the safety stock maintained is adequately low then the inventory carrying charges on the safety stock will be low, but stock-outs will be frequently experienced, hence stock out costs would be very high. Stock-outs may affect the hospital's functioning in the following ways:

1. The quality of patient care is affected adversely
2. Patient dissatisfaction
3. Emergency purchase of stores at a high cost

Formula:
(Maximum daily usage * Maximum lead time in days) – (Average daily usage * Average lead time in days).

Brief history of the COVID-19 Pandemic

On 31 December 2019, the World Health Organization (WHO) became aware of a cluster of pneumonia of unknown etiology reported in Wuhan, People's Republic of China. On 30 January, WHO declared a Public Health Emergency of a Global Concern. The virus was initially named the 2019 novel coronavirus (2019-nCoV). However, on 11 February 2020, the new coronavirus was given the official name Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), and the disease caused by the virus was named corona-virus disease 2019 (COVID-19). SARS-CoV-2 started to spread rapidly across the world, and WHO made the assessment and characterized it as a pandemic on 11 March 2020.

Central role of testing in the response

Testing is part of the first line of defence against COVID-19, enabling early identification and isolation of cases to slow transmission, provision of targeted care to those affected, and protection of health system operations. Laboratory tests for COVID-19 based on Nucleic Acid Amplification Techniques (NAAT) were rapidly developed in the early days and weeks of the pandemic, but such tests typically require sophisticated laboratory infrastructure and skilled staff. To date, hundreds of millions of COVID-19 tests have been performed globally, but the demand for timely, accurate testing continues to outstrip supply. WHO recommends that persons meeting the suspected COVID-19 case definition be tested immediately in order to confirm or rule out infection with SARS-CoV-2. In the situations where testing is not possible, a probable case of COVID-19 may instead be reported based on certain epidemiological criteria and clinical symptoms or signs. It is expected that Rapid Antigen Testing will greatly expand access to testing, enabling the most accurate estimates of disease intensity and enabling the concerned health authorities to take proper control measures appropriate to the given situation.

Urgent needs in the pandemic response

The first step of action required towards controlling COVID-19 requires testing infrastructure that can be scaled up to provide access to enhanced and improved testing in a decentralized setting and environment.

The challenge of the limited coverage of laboratory services and long turnaround times has meant that NAAT (such as real-time reverse transcription polymerize chain reaction [RT-PCR]) capacity has been unable to meet the testing demand in Telangana State in India.

Molecular testing

WHO recommends that, wherever possible, suspected cases with active SARS-CoV-2 infection be tested using molecular NAAT methods, such as RT-PCR, which detects the presence of viral RNA in patient samples from the respiratory tract but also in oral fluid, saliva, and stool. The optimal specimen for NAAT methods depends on the clinical presentation and time since symptom onset. Further information on specimen types for molecular testing can be found in the document Diagnostic testing for SARS-CoV-2. Given the risk of potential exposure to the virus during sample collection and when handling respiratory samples, technicians must follow recommended bio-safety guidance and adhere strictly to infection prevention and control procedures.

During the COVID-19 pandemic, Telangana aggressively launched 32 RTPCR Labs and seeing the necessity of the labs, the state has scaled up laboratory testing capacity amid a number of challenges encountered. One of the challenges is that NAATs, an essential part of the testing response to COVID-19, typically require well-resourced laboratory facilities, multiple reagents, sample referral systems and skilled personnel.

However, many settings lack the sophisticated infrastructure required to provide widespread molecular testing for COVID-19. On top of that, long transport distances for referral and slow turnaround times limit the impact of molecular testing for COVID-19 clinical and public health, where timely detection is critical. Supply shortages of essential and compatible reagents pose a further complicated challenge in the process of scaling up of molecular testing for COVID-19 in certain settings. The high cost of molecular testing also limits the testing coverage that can be achieved within countries' diagnostic funding envelopes. Similarly, access and price remain substantial barriers to point-of-care of Molecular Testing in many settings in Telangana State.

Rapid Diagnostic Testing

Given this situation SD Biosensor a KOREAN based company introduced RAT Testing at pointing care in May 2020 at a low cost of Rs.1470/- (comparative RTPCR Testing Rs. 1900).

RDTs are easy-to-use, rapid tests that can be used at or near the point of care, without the need for laboratory infrastructure or expensive equipment. There are two types of SARS-CoV-2 RDTs: antigen (Ag) tests that directly detect the SARS-CoV-2 virus antigen(s), and antibody (Ab) tests that detect one or more types of antibodies produced by the host immune response against the virus.

Rapid Diagnostic Tests: Anti-body Detecting Tests

Advantages

1. RAT kits can be used to detect previous infections with SARS-CoV-2.
2. It can be used at the point of care (outside laboratories) or in higher throughput formats in laboratories
3. Easy to perform
4. Quick results (typically under 30 minutes for point-of-care testing)
5. Less expensive than NAAT, e.g., RT-PCR tests

Disadvantages

1. The clinical significance of a positive Ab-RDT result is still under investigation
2. Positive Ab-RDT results do not guarantee the presence of neutralizing antibodies or protective immunity
3. Ab-RDTs should not be used for determining active infections in clinical care or for contact-tracing purposes
4. The interpretation of Ab-RDT results depends on the timing of the disease, clinical morbidity, the epidemiology and prevalence within the setting, the type of test used, the validation method, and the reliability of the results

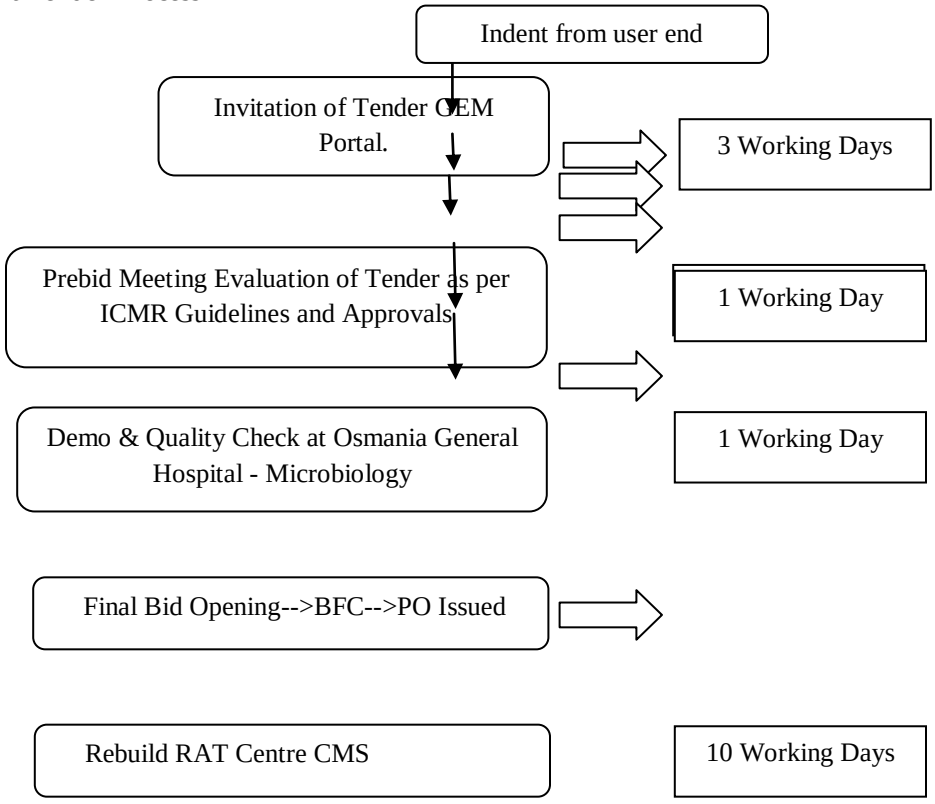
RAT kits for COVID-19

Criteria for RAT Procurement at TSMSID

1. Selecting ICMR approved RAT.
2. The next step is to select a good-quality product based on specifications such as performance, thermal stability, cost, intended use and suitability.

The transparent tender process through the GEM Portal is as follows:

Short Tender Process



Supply Chain Management of Rapid Antigen Kits

In Telangana State, there are 10 Districit Central Medical Stores (DCMS), and these 10 stores cater to 90-100 health facilities ranging from PHCs to Teaching Hospitals within a radius of 150-200kms for the supply of RAT kits.

The respective successful vendor, based in Hyderabad, supplies the RAT kits to Central CMS based on a need, targets to be achieved, and available stock of the D-CMS. The TSMSIDC office distributed the received supplies once in every 3 days, through six geographically identified locations within a radius of 150-200kms from central CMS Hyderabad to District CMS.

The existing CMS's are overloaded due to the enhanced importance of the National Programme to minimize out-of-pocket expenditure of the patients, and to provide quality of health care to patients to increase patient satisfactory level the Govt of Telangana has been strengthened and expended the communicable disease (CD) and Non-Communicable Disease Programme (NCO), Maternal health child health Programme and Diagnostic Programme, Govt of Telangana has introduced new programs like KCR kit, KantiVelugu and Health survey Program. For all the above programs, concerned materials should be maintained to deliver the right quantity to the right place. Some of the programs are taken major initiatives and newly prioritized based on health problems, disease burden in this situation, RAT kits supply to health facilities additional extra work to D-CMS in high priority basis in Telangana State.

For transportation of RAT Kits to facility level it will take more time due to most of health facilities are in rural and tribal areas like Bhadrachalam, Utnoor, Achampet, Eturnagaram with 150-200 km radius and catering around 90-100 health facilities.

Cost Control Data Analysis of RAT

S. No	Date of Tender floating	Date of BFC	Qty Ordered	Rate	PO issued	Receiving date	Total Order Cost	Internal Lead Time	External Lead Time	Total Lead Time	Cost Reduction	Cost Increase
A	B	C	D	E	F	G	H= (D X E)	I= (C-B)	J =(G-F)	K = (I +J)	L	M
1	15-06-2020	15-06-2020	200000	504	03-07-2020	08-07-2020	10,08,00,000	0	5	5		
2	15-06-2020	15-06-2020	200000	504	19-07-2020	04-08-2020	10,08,00,000	0	16	16		
3	15-06-2020	15-06-2020	100000	504	21-07-2020	04-08-2020	5,04,00,000	0	14	14		
4	06-08-2020	06-08-2020	300000	459.2	06-08-2020	12-08-2020	13,77,60,000	0	6	6		
5	06-08-2020	06-08-2020	200000	459.2	10-08-2020	19-08-2020	9,18,40,000	0	9	9		
6	06-08-2020	06-08-2020	500000	459.2	14-08-2020	28-08-2020	22,96,00,000	0	14	14		

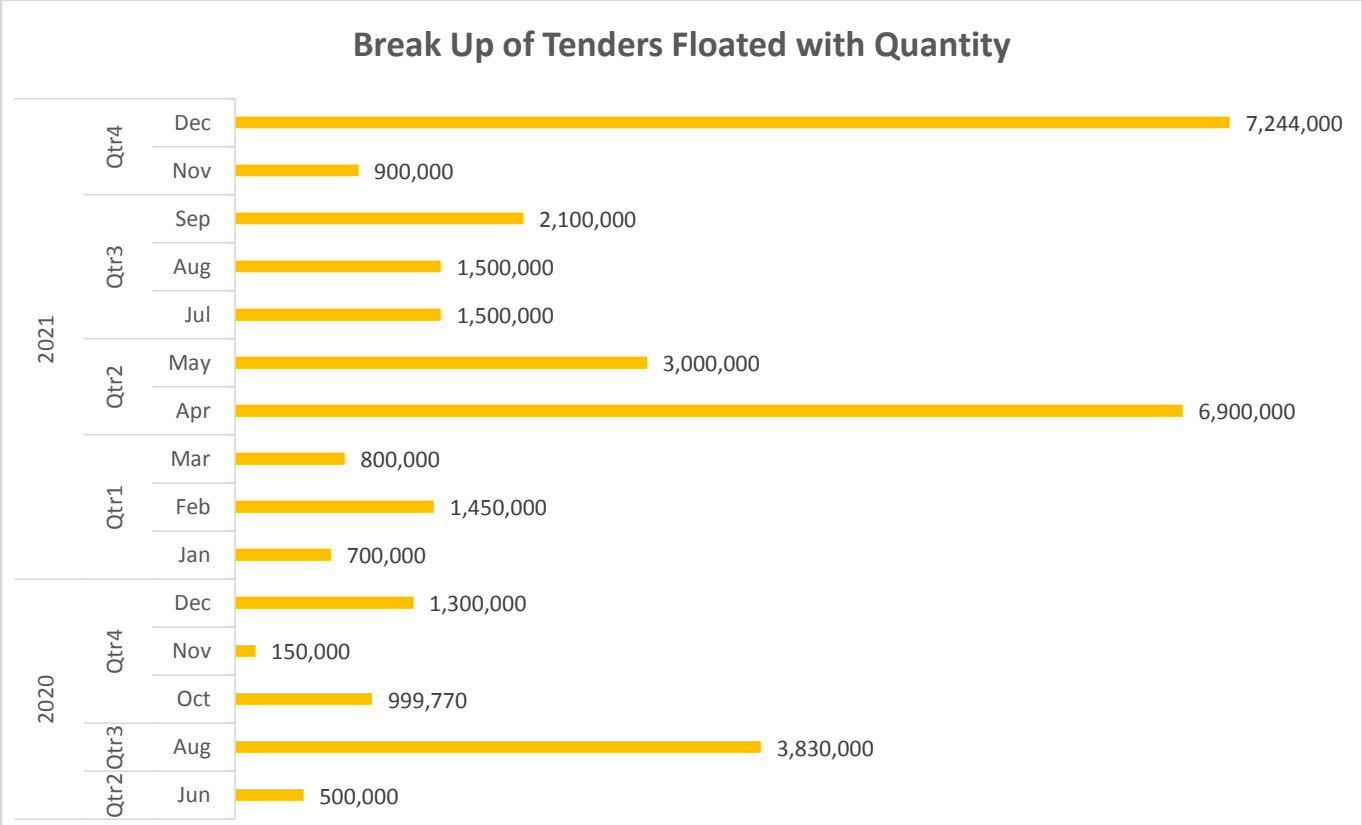
7	06-08-2020	06-08-2020	500000	459.2	27-08-2020	03-09-2020	22,96,00,000	0	7	7		
8	06-08-2020	06-08-2020	500000	459.2	05-09-2020	15-09-2020	22,96,00,000	0	10	10		
9	06-08-2020	06-08-2020	30000	459.2	10-09-2020	28-09-2020	1,37,76,000	0	18	18	11,33,44,000	
10	12-08-2020	29-09-2020	500000	459.2	16-09-2020	05-11-2020	22,96,00,000	48	50	98		
11, 12, 13	12-08-2020	29-09-2020	1300000	414.4	08-10-2020	05-11-2020	53,87,20,000	48	28	76	5,82,40,000	
14-16	01-10-2020	11-11-2020	500000	274.4	12-11-2020	21-11-2020	13,72,00,000	41	9	50	9,09,67,800	
										0		
										0		
15	01-10-2020	11-11-2020	149770	274.40	13-11-2020	28-11-2020	4,10,96,888	41	15	56	-	
										0		
										0		
17	01-10-2020	11-11-2020	350000	150.08	30-11-2020	03-12-2020	5,25,28,000	41	3	44	4,35,12,000	
										0		
										0		
18	26-11-2020	10-12-2020	150000	100.23	10-12-2020	16-12-2020	1,50,34,500	14	6	20	74,77,500	
19-21	11-12-2020	18-12-2020	1000000	62.72	18-12-2020	11-01-2021	6,27,20,000	7	24	31		
										0		
22	11-12-2020	18-12-2020	300000	62.72	12-01-2021	22-01-2021	1,88,16,000	7	10	17		
										0	4,87,63,000	
23	02-01-2021	01-02-2021	200000	49.72	02-02-2021	06-02-2021	99,44,000	30	4	34		
										0		z
24-26	02-01-2021	01-02-2021	500000	49.72	04-02-2021	27-02-2021	2,48,60,000	30	23	53		
										0	91,00,000	
27-30	17-02-2021	02-03-2021	1450000	37.83	04-03-2021	30-03-2021	5,48,53,500	13	26	39		
										0	1,72,40,500	

31	22-03-2021	06-04-2021	500000	36.96	06-04-2021	22-04-2021	1,84,80,000	15	16	31		
32	22-03-2021	06-04-2021	300000	36.96	06-04-2021	22-04-2021	1,10,88,000	15	16	31		
33	03-04-2021	09-04-2021	500000	36.96	09-04-2021	16-04-2021	1,84,80,000	6	7	13		
34	12-04-2021	17-04-2021	700000	36.96	17-04-2021	25-04-2021	2,58,72,000	5	8	13	17,40,000	
35	13-04-2021	20-04-2021	1500000	34.6	20-04-2021	24-04-2021	5,19,00,000	7	4	11		
36	13-04-2021	20-04-2021	900000	34.6	20-04-2021	26-04-2021	3,11,40,000	7	6	13		
37	13-04-2021	22-04-2021	500000	89.6	22-04-2021	28-04-2021	4,48,00,000	9	6	15		
38	13-04-2021	22-04-2021	400000	34.6	22-04-2021	30-04-2021	1,38,40,000	9	8	17	66,08,000	
39	20-04-2021	27-04-2021	1500000	76.16	27-04-2021	03-05-2021	11,42,40,000	7	6	13		
40	20-04-2021	27-04-2021	900000	76.16	27-04-2021	06-05-2021	6,85,44,000	7	9	16		-9,97,44,000
41	20-05-2021	24-05-2021	1500000	72.8	24-05-2021	29-05-2021	10,92,00,000	4	5	9		
42	21-05-2021	25-05-2021	900000	72.8	25-05-2021	01-06-2021	6,55,20,000	4	7	11	80,64,000	
43	25-05-2021	31-05-2021	600000	67.2	31-05-2021	12-06-2021	4,03,20,000	6	12	18	33,60,000	
44	26-07-2021	03-08-2021	1500000	18.6	03-08-2021	13-08-2021	2,79,00,000	8	10	18		

45	12-08-2021	18-08-2021	900000	18.6	18-08-2021	28-08-2021	1,67,40,000	6	10	16		
46	12-08-2021	18-08-2021	2000	18.6	18-08-2021	29-08-2021	37,200	6	11	17		
47	19-08-2021	26-08-2021	598000	18.6	26-08-2021	01-09-2021	1,11,22,800	7	6	13	14,58,00,000	
48	15-09-2021	20-09-2021	2100000	8.67	20-09-2021	28-09-2021	1,82,07,000	5	8	13	2,08,53,000	
49	27-11-2021	01-12-2021	900000	9.24	01-12-2021	13-12-2021	83,16,000	4	12	16		-5,13,000
50	08-12-2021	15-12-2021	3000000	6.13	15-12-2021	23-12-2021	1,83,90,000	7	8	15	93,30,000	
51	31-12-2021	06-01-2022	1750000	9.57	06-01-2022	11-01-2022	1,67,47,500	6	5	11		
52	31-12-2021	06-01-2022	1500000	9.57	06-01-2022	11-01-2022	1,43,55,000	6	5	11		
53	31-12-2021	07-01-2022	250000	9.57	07-01-2022	11-01-2022	23,92,500	7	4	11		
54	31-12-2021	07-01-2022	744000	9.57	07-01-2022	11-01-2022	71,20,080	7	4	11		-1,45,99,360
	Total in Rupees		**3,28,73,770**				**3,12,43,00,968**	**490**	**490**	**980**	**58,43,99,800**	**-11,48,56,360**

Cost Control Data Analysis of RAT

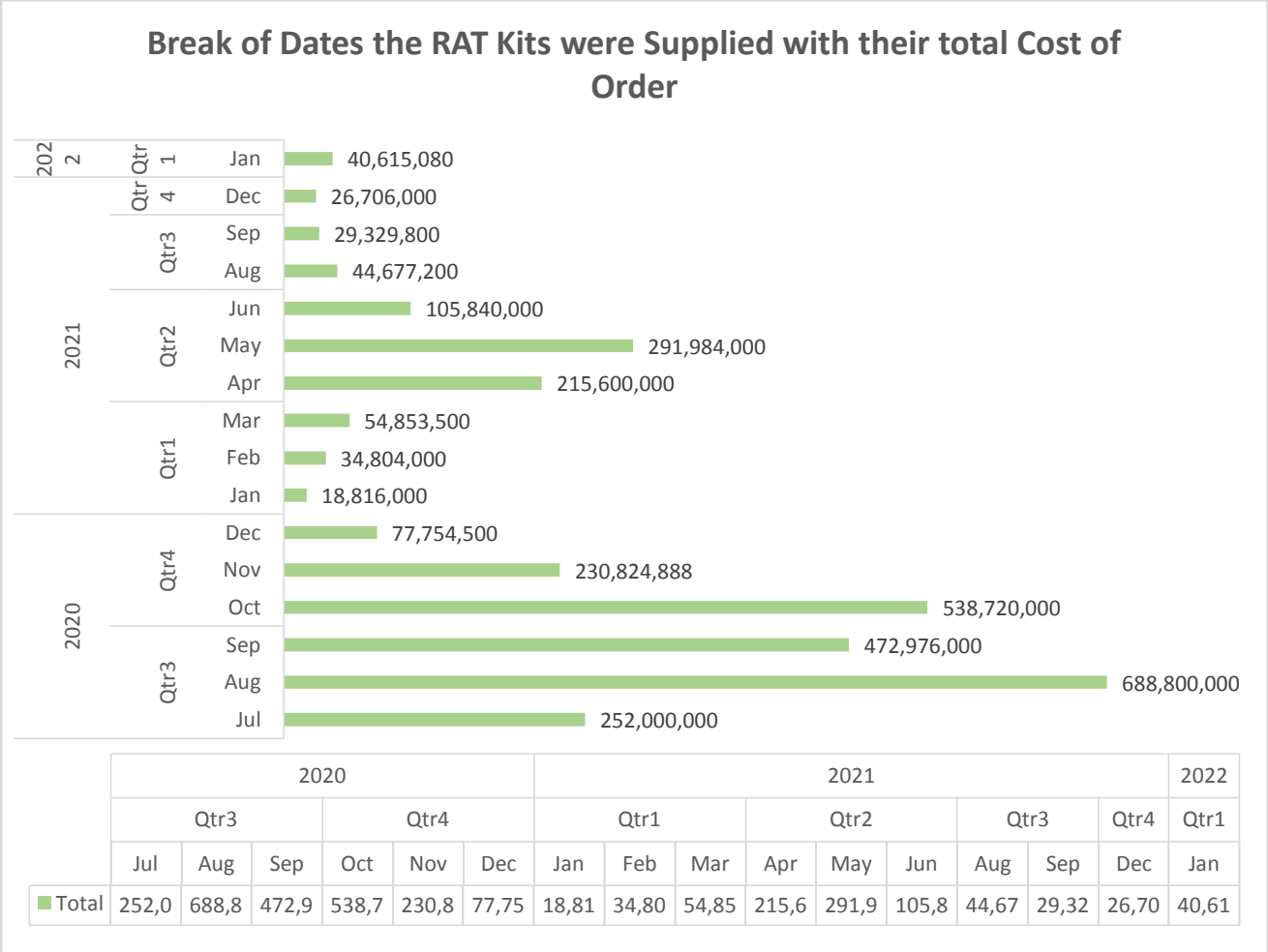
The process was initiated, and tenders were floated for the procurement of the RAT Kits in the 2nd Quarter of 2020, beginning from June, 2020.



	2020					2021									
	Qtr2	Qtr3	Qtr4			Qtr1			Qtr2		Qtr3			Qtr4	
	Jun	Aug	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jul	Aug	Sep	Nov	Dec
Total	500,00	3,830,	999,77	150,00	1,300,	700,00	1,450,	800,00	6,900,	3,000,	1,500,	1,500,	2,100,	900,00	7,244,

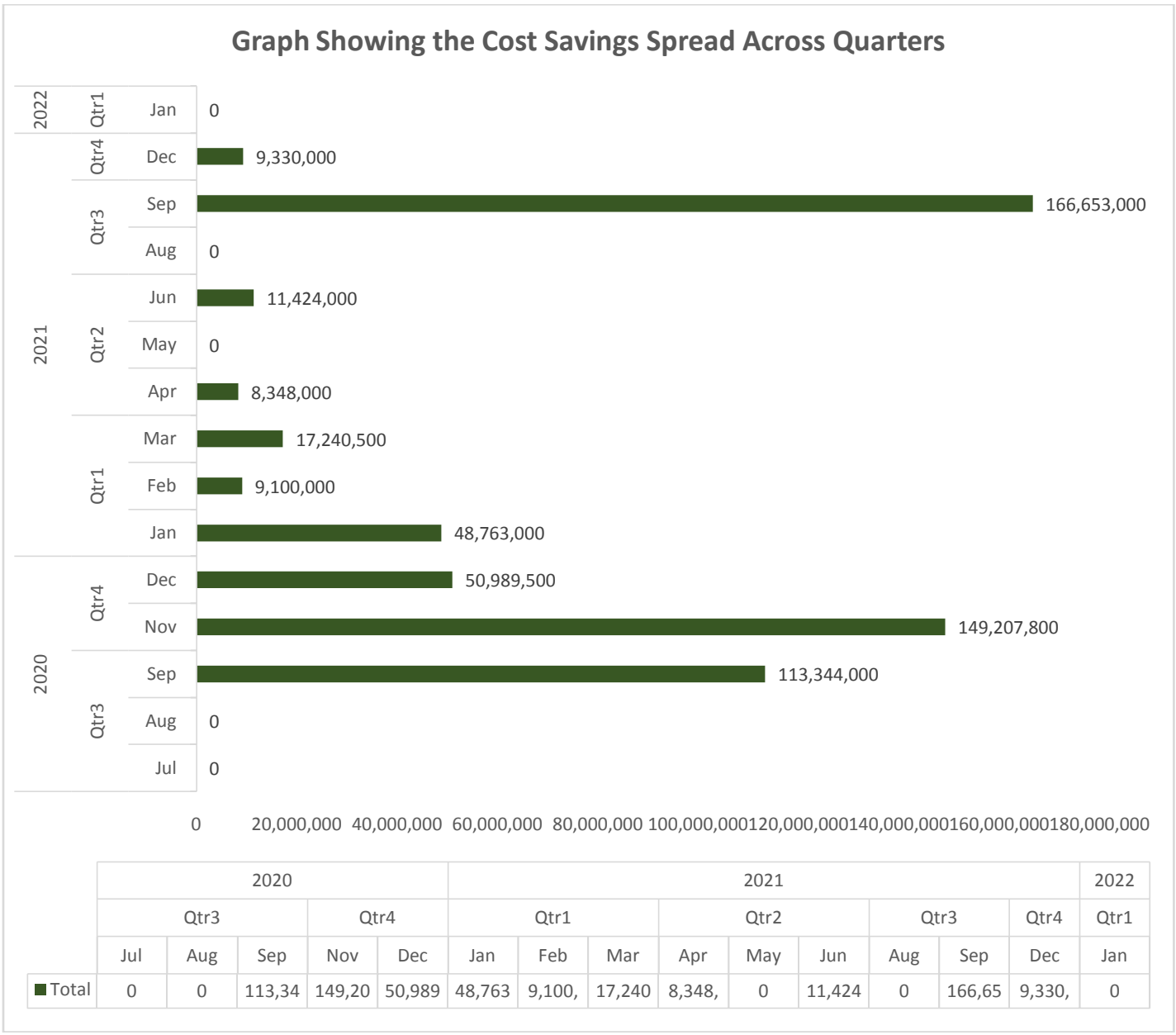
The chart depicts an overview of our endeavour to procure even small quantities of RAT KITS, keeping in view, at a macro level of the Covid-19 pandemic. As the intensity of the pandemic grows, we must ensure that we gear-up to meet the demands of the testing equipment across the Telangana state.

The chart depicted below is an overview of how we started with procurement of RAT KITS, even of the small quantity, and gradually increased the quantity of procurement, in accordance with the growing pandemic testing requirements across Telangana state. We ensured to follow the most robust processes without compromising on the demand situation during the Pandemic.



	2020						2021									2022
	Qtr3			Qtr4			Qtr1			Qtr2			Qtr3		Qtr4	Qtr1
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Dec	Jan
Total	252,0	688,8	472,9	538,7	230,8	77,75	18,81	34,80	54,85	215,6	291,9	105,8	44,67	29,32	26,70	40,61

The lead procurement times have been kept to as minimalist as possible, marked in Green, keeping in view of the larger interests of the Covid testing requirements for the people in Telangana. The table depicted below is an overview of the cost of savings worth Rs.58 crores.



	2020					2021									2022
	Qtr3			Qtr4		Qtr1			Qtr2			Qtr3		Qtr4	Qtr1
	Jul	Aug	Sep	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Dec	Jan
Total	0	0	113,34	149,20	50,989	48,763	9,100,	17,240	8,348,	0	11,424	0	166,65	9,330,	0

The aforesaid is possible due to a positive effect of the good governance and swift action of TSMSIDC, that is ably supported by the Government of Telangana, to achieve the savings to the government ex-chequer. Yet, we feel that we could better and strive in our endeavour in a set direction.

Insights

1. Tenders were floated in the IGEM portal while following all the tender specifications as per ICMR guidelines.
2. Only ICMR-approved Original Equipment Manufacturers (OEMs) were allowed to participate in the tender process.
3. Out of 14 ICMR-approved, OEMs for RAT, on an average 6-7 OEMs participated each time.
4. While issuing the purchase orders, we considered L1, L2 & L3 participants for smooth functioning to avoid delay in the supply of RAT kits with price matching of the L1 bidder.
5. It was observed that the average number of tests is around 9-10 lakhs per month during the 1st wave of COVID-19. Later, it increased to 12-14 Lakhs per month in the peak level of COVID-19 i.e., during the 2nd and 3rd waves. On average, 18-20 lakhs tests were conducted per month during Fever Survey conducted by the Government of Telangana.
6. Out of the 3.28 crores procured RAT kits, the consumption was around 2.78 crores as of 14.10.2022 in two years of supply for testing of COVID-19 at the point of care.
7. A huge raise in the consumption of RAT kits was observed during the 2nd wave of COVID-19 i.e., April-June 2021
8. There is a huge raise in consumption of RAT KITS during Oct-Dec 2021 as the Government of Telangana conducted the fever survey, house-to-house with following methods:

a. Testing: Testing of RAT at point of care.
b. Treatment: If fever exists COVID19 treatment kit (which contains 7 medicines) issued to patient irrespective of COVID-19 positive.
c. Transfer: If oxygen levels are below 90%, patient is transferred to nearest health facility.

9. Internal Lead Time is calculated from the date of the tender to the date of PO issued order is average
10. External Lead Time is calculated from the date of the tender to the date of PO issued order is average
11. The Total Lead Time is 18.15 days is on an average for total supply of RAT's Rs.3.28 crores order quantity with worth of Rs.312 crores in repeated tender floated as per market's demand & supply.
12. We have floated around 54 times in 1 and a half year of period based on demand & market value. In this process, around 57.7(18.5%) crores saved out of Rs. 312 crores.
13. We observed that 11.49(3.7%) crores out 312 crores is an incremental demand of COVID-19 in 2nd and 3rd wave, which was at the peak level.

Suggestions:-

1. In supply chain management, only 10 District Central Medical Stores (CMS) are available, which delayed the supply to reach the point of care in a distance of over and above 150 kms. For an effective supplies, suggested increase in the district CMS from the present 10 stores to 12 stores.
2. We observed that Pharmacist Grade II sanction posts are two(2) in number in each CMS. But most of the CMS are posted only one(1) Pharmacist Grade II. Please examine recruiting or deputing 1 more Pharmacist Grade II to all the CMS.
3. Inventory control methods are not practiced at CMS level for easy management of supply of the inventory. It is recommended to train all the Pharmacists on Inventory Control.
4. State level Quarterly Internal Audit to be conducted to check and avoid any deviations that impacts the Inventory Control.

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