

CHAPTER – VII

Department of Space

7.1 Operationalisation of Satellite Navigation System

NAVIC was approved by the Government of India in May 2006 at a cost of ₹ 1,420 crore to establish an independent and indigenous satellite based navigation system over the Indian landmass and surrounding region. An expenditure of ₹ 1,283.93 crore had been incurred on the programme so far. However, the system has yet to be operationalised due to delays in execution of contracts, deficient monitoring of programme and inadequate follow up. In addition, ₹ 3.57 crore were spent on unnecessary procurement of modems.

7.1.1 Introduction

Navigation with Indian Constellation (NAVIC)⁴¹ is an initiative of the Indian Space Research Organisation (ISRO), Department of Space (DOS), to build an independent satellite navigation system to provide Position, Navigation and Timing (PNT) services over a Primary Service Area (PSA) comprising of India and its surrounding region extending up to 1,500 km. NAVIC envisaged applications in terrestrial, aerial and marine navigation, disaster management, vehicle tracking and fleet management, integration with mobile phones, precise timing, mapping and geodetic data capture, terrestrial aid for hikers and travellers and visual and voice navigation for drivers. ISRO identified (March 2006) Railways, land transport, mobile communication and general public as the potential civilian users and Defence and security applications as the non-civilian users.

NAVIC consists of a space segment, ground segment and user segment. The space segment comprises of a constellation of seven satellites (IRNSS-1A, IRNSS-1B, IRNSS-1C, IRNSS-1D, IRNSS-1E, IRNSS-1F and IRNSS-1G) which were launched between July 2013 and April 2016. The ground segment is responsible for maintenance and operation of the NAVIC constellation. The user segment comprises frequency user receivers capable of receiving NAVIC signals.

Government of India accorded (May 2006) financial sanction of ₹ 1,420 crore for NAVIC. As of March 2017, expenditure of ₹ 1,283.93 crore had been incurred under

⁴¹ Initially known as Indian Regional Navigation Satellite System (IRNSS).

the programme. In addition, expenditure of ₹ 1,162.21 crore⁴² was incurred on launch vehicles and maintenance of the satellites and the ground segment.

The Satellite Navigation Programme Office (SNPO) at ISRO Head Quarters was responsible for the overall coordination of the NAVIC programme. In addition, a Project Management Council (PMC) and a Project Management Board (PMB) were constituted (July 2006) for monitoring the progress of the programme.

An audit of the management of NAVIC was carried out covering the period 2012-17. Audit findings are discussed in the succeeding paragraphs.

7.1.2 Audit Findings

7.1.2.1 Non-operationalisation of NAVIC programme

The development and deployment of NAVIC constellation, ground infrastructure, navigation, safety and certification, verification software was expected to be completed within five to six years from the date of approval of the project i.e. by December 2011. However, the NAVIC programme was not operational as of June 2017 due to delays in realisation of various segments.

7.1.2.2 Delay in realisation of NAVIC components

Audit reviewed 45 contracts⁴³ awarded for realisation of various components under the three segments of the NAVIC programme. Of the 45 contracts, 37 contracts related to procurement of equipment and systems and eight contracts pertained to award of civil works. Audit observed delays in the execution of these contracts at each stage ranging from two years to nearly nine years. Audit also observed overall delay ranging from three months to more than nine years from the date of approval of the NAVIC programme in the completion of 11 components of the contracts as given in Table 7.1 below.

Table 7.1: Component-wise delay in execution of contracts for NAVIC components

| Segment | Component | Purchase contracts (delay in months) | | | Works contracts (delay in months) | | |
|-------------------|------------------------------|-----------------------------------------|------------------|------------------|--------------------------------------|------------------|------------------|
| | | No. | Minimum delay | Maximum delay | No. | Minimum delay | Maximum delay |
| Space segment | (1) INC | - | - | - | 6 | 39 | 118 |
| Ground segment | (2) Navigational Software | 1 | - | 31 | - | - | - |
| | (3) Communication link | 2 | 66 | 104 | - | - | - |
| | (4) IRIMS | 2 | 44 | 58 | - | - | - |
| User segment | (5) IRNWT | 2 | 38 | 101 | - | - | - |

⁴² Includes cost of launch of the seven satellites: ₹ 1,117.06 crore; expenditure incurred towards maintenance of NAVIC satellites ₹ 42.75 crore; and expenditure incurred towards maintenance of ground segments ₹ 2.40 crore.

⁴³ All contracts that were directly related to NAVIC programme were selected for audit.

| Segment | Component | Purchase contracts (delay in months) | | | Works contracts (delay in months) | | |
|---------|---------------------------------|-----------------------------------------|------------------|------------------|--------------------------------------|------------------|------------------|
| | | No. | Minimum delay | Maximum delay | No. | Minimum delay | Maximum delay |
| | (6) IRCDR | 6 | 3 | 111 | 2 | 69 | 73 |
| | (7) SCC | 4 | 69 | 112 | - | - | - |
| | (8) Signal Monitoring | 1 | - | 110 | - | - | - |
| | (9) Atomic Clock | 2 | 61 | 71 | - | - | - |
| | (10) Other Space Consumables | 8 | 25 | 116 | - | - | - |
| | (11) User Devices | 9 | 65 | 112 | - | - | - |

The delays were attributed to sites not being ready, revisions in the technical specifications, non-compliance with contract specifications by the contractor, administrative reasons, delays in shipment and delays in completion of civil works as tabulated in **Appendix XIII**. While some of causes for the delay were unforeseeable and beyond the control of ISRO/DOS, a substantial part of the delays were attributable to inadequate follow-up, lack of coordination with Government and other agencies as well as sheer administrative laxity. As a result, the components could not be realised within the stipulated duration of the programme (December 2011) and 36 out of the 45 contracts remained unfulfilled as of December 2011.

Audit further observed that seven contracts remained unfulfilled even as of May 2017 after more than five years from the schedule date of completion of the programme. The delay in completion of activities under the contracts from 31 December 2011 as of 31 May 2017 is given in Table 7.2 below.

Table 7.2: Component wise delay in fulfilment of contracts in NAVIC

| Segments | Components | Contracts Reviewed | Total no. of contracts unfulfilled at the end of Dec 2011 | Range of delay in months up to 31 May 2017 | | Total no. of contracts unfulfilled at the end of May 2017 |
|-----------------------|-------------------------|--------------------|-----------------------------------------------------------|--------------------------------------------|---------|-----------------------------------------------------------|
| | | | | Minimum | Maximum | |
| Ground Segment | INC | 6 | 5 | 36 | 61 | - |
| | Navigational Software | 1 | - | -- | -- | - |
| | Communication link | 2 | 2 | 17 | 66 | 1 |
| | IRIMS | 2 | 2 | 21 | 25 | - |
| | IRNWT | 2 | 1 | -- | -- | 1 |
| | IRCDR | 8 | 5 | 13 | 63 | - |
| | SCC | 4 | 4 | 24 | 66 | 1 |
| | Signal Monitoring | 1 | 1 | -- | 49 | - |
| Space Segment | Atomic Clock | 2 | 2 | 28 | 32 | - |
| | Other Space Consumables | 8 | 5 | 31 | 66 | 2 |
| User | User Devices | 9 | 9 | 15 | 66 | 2 |
| | TOTAL | 45 | 36 | | | 7 |

Thus, delays in award and execution of contracts for NAVIC components resulted in non-realisation/ delay in realisation of these components leading to non-operationalisation of NAVIC programme within the schedule duration and even after five years of the target date.

7.1.2.3 Delay in realisation of user devices development programme

ISRO identified (October 2004/ April 2006) development of user receivers as a critical technology component of the programme. The Cabinet sanctioned ₹ 200 crore for the development of critical technologies including user receivers.

In a PMC meeting held in May 2008, it was decided to explore the option of development of user receivers by a private agency and to enter into a development contract for this purpose. While ISRO procured (September 2012 to February 2017) user receiver equipment at a cost of ₹ 24.04 crore for various government agencies, academic institutes and ISRO centres for IRNSS field trials as well as three Global Navigational Satellite System (GNSS) simulators (June 2012 to August 2014) for testing of the user devices, the announcement of user development programme involving academia, research institutes and individuals for development of the user devices was initiated only in March 2017 with a budget allocation of ₹ 13.50 crore.

ISRO stated (September 2016) that development of the user segment was the responsibility of the user. The reply is not tenable as ISRO was required to develop critical technologies for the user receiver devices as approved by the Cabinet. The reply also contradicts the fact that the ISRO has eventually taken up the user development programme in March 2017.

7.1.2.4 Non-completion of performance evaluation

As per the approval of the Cabinet, certification of NAVIC was required to be done in order to provide seamless continuous PNT service to users. At its meeting held on 11 August 2009, the Project Management Board recorded that the characteristics of the user receivers have to be sent to the International Telecommunication Union (ITU) as per the regulations. The Project Management Council, in its meeting held in April 2016, stated that performance evaluation of IRNSS in the PSA was required to be evaluated in the Indian land mass and in places outside India within the PSA before NAVIC could be declared as operational.

Audit noticed that certification and validation of the NAVIC programme including performance evaluation was not done as of September 2016.

ISRO stated (September 2016) that evaluation and validation of NAVIC was in progress.

7.1.2.5 Unnecessary procurement of modems

Para 2.4.2 of DOS Purchase Procedure, 2009 stipulates that a Need Aspect Committee consisting of technical experts from the relevant field should examine the

need and appropriateness of specifications of equipment and systems proposed for procurement.

ISRO was to establish four IRNSS CDMA ranging stations (IRCDRs). In order to acquire ranging signals, the four stations required eight modems. There are two types of modems available in the market viz. SATRE and CORTEX. ISRO was in possession of both these modems for its various applications. While SATRE modems are used to acquire ranging signals from the satellites at Geo Stationary Orbit (GEO), CORTEX modems are required for satellites in both GEO and Geo Synchronous Orbit (GSO). Out of the seven NAVIC satellites, four satellites (IRNSS 1A, 1B, 1D and 1E) were positioned at GSO and remaining three satellites were positioned (IRNSS 1C, 1F and 1G) at GEO.

Space Applications Centre, Ahmedabad (SAC) procured eight (two modems in July 2007 and six modems in February 2008) SATRE modems from a foreign firm at a total cost of ₹ 3.57 crore. Subsequently in August 2016, ISRO Tracking, Telemetry and Command Network bought eight CORTEX modems from another foreign supplier at a cost of ₹ 2.98 crore on the ground that the previously acquired SATRE modems were not able to acquire ranging signals from satellites in GSO orbit.

Audit observed that the fact that four of the NAVIC satellites were in GSO must have been known to the Need Aspect Committee and this should have been taken into account while procuring the modems.

Failure of ISRO to match the procurement of the modems with the satellites resulted in unnecessary procurement of eight SATRE modems at a cost of ₹ 3.57 crore.

7.1.3 Conclusion

NAVIC that was to be operational by December 2011 was not made operational even at the end of June 2017 due to which position, navigation and timing services envisaged under the programme could not be provided to the users. Though the space segment has been completed, NAVIC remained non-operational due to non-completion of Ground segment and User segment. There were delays in realisation of key components under the programme which led to idling of the satellites. As the life of a navigational satellite is 10 to 12 years and the satellites already launched under the programme remained idle for 14 months to four years, delay in realisation of the NAVIC programme would limit the duration of their utility once the programme became operational. In addition, ground segment infrastructure created for the NAVIC satellites also remained unutilised.

The matter was referred to DOS in October 2017; its reply was awaited as of December 2017.

7.2 Infertuous expenditure on software development

Failure to implement and properly monitor a project on development of Digital Workflow System by the Department of Space resulted in non-development of the software for more than 11 years since its initiation despite expenditure of ₹ 2.27 crore.

The Department of Space (DOS) is responsible for promoting the development of space science and technology and space applications for national development. The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and executes the Indian space programme.

DOS developed an in-house package named “Computerised Working in Administrative Areas (COWAA)” for computerisation of its Administration, Finance, Payroll, Purchase and Stores functions and deployed it across all its centres in a phased manner from 2002⁴⁴ onwards. With a view to bringing in radical changes in administrative work processes, live monitoring of ISRO projects, connectivity of all DOS/ISRO Centres/external agencies and to develop MIS services, DOS constituted (April 2006) an inter-centre Committee to undertake a detailed system analysis, process re-engineering and establishment of an integrated Digital Workflow System (DWFS) in all groups of administration.

The Committee submitted its report in January 2007. DOS issued (July 2007) orders envisaging that the DWFS would be built upon the COWAA system and would eventually replace COWAA in a phased manner. The development and implementation of DWFS was scheduled to be completed within 20 months i.e. by March 2009 at an estimated cost of ₹ 10 crore. DOS constituted (July 2007) a Project Management Council (PMC) to provide policy guidelines, approve the change management procedures and practices and review the project periodically for effective implementation. A Project Management Board (PMB) was also constituted (September 2008) for ensuring speedy development and implementation of DWFS.

The development of DWFS did not progress as envisaged. Since the progress was not satisfactory and the project functionaries requested for additional human resources, ISRO directed (July 2009) that three of its centres viz. Satish Dhawan Space Centre, Sriharikota (SDSC), Vikram Sarabhai Space Centre, Thiruvananthapuram (VSSC) and Liquid Propulsion Systems Centre, Valiamala (LPSC) would take the responsibility of development of DWFS. While SDSC was assigned 16 modules, VSSC and LPSC were entrusted with 10 and 13 modules respectively. In October 2009, DOS/ISRO constituted a Standing Review Committee⁴⁵ (SRC) and Verification and Validation

⁴⁴ The project was initiated in 1997.

⁴⁵ Committee constituted to review the (a) Software Requirement Documents; (b) Architectural Design; (c) Prototype Design; (d) Detailed Design; (e) Verification & Validation and Technical & Evaluation Committee Reports; (f) Change Control Board Recommendation.

Committee⁴⁶ (V&V) to review the Software Requirement Document, Verification and Validation and Technical and Evaluation Committee Reports and prepare Test Plan Document.

The progress of work continued to remain slow. The DWFS project teams reported (August 2015) that development of 80 *per cent* of modules allocated to SDSC was completed while the module development work entrusted to VSSC and LPSC was yet to start. It was also reported that out of the modules developed by SDSC, only the leave module was deployed in SDSC. However, this module was not deployed in other centres of DOS. The project teams stated that the progress of DWFS was hindered due to lack of in-house expertise, non-deployment of dedicated development team, other priority issues, non-identification of domain experts for work flow requirements and non-existence of review committees as many members had retired. Consequently, DWFS was not developed/deployed as of March 2017 though DOS had incurred an expenditure of ₹ 2.27 crore on hardware, software and consultancy.

Audit observed that the various review committees constituted by DOS did not perform the tasks envisaged. The PMC did not provide policy guidelines, approve the change management practices and review the project periodically. It held its first meeting in March 2008 when it identified the action items. It did not meet anytime thereafter to discharge the duties assigned to it. The PMB also did not ensure speedy development and implementation of DWFS. It held its last meeting in October 2010 and did not review the project thereafter. The minutes of this meeting indicated that DWFS was still being developed. The last meeting of the V&V was held in December 2010 and that of SRS in February 2011 indicating that the project was not pursued further.

Thus, poor monitoring of the project and failure to address the issues faced in project implementation in a coherent manner resulted in non-development of DWFS for more than 11 years since its conception despite expenditure of ₹ 2.27 crore.

The matter was referred to DOS (October 2017); its reply was awaited as of December 2017.

⁴⁶ Committee constituted for (a) preparation of standard template document for SRS, Design and Test Document; (b) review SRS document, Design Document; (c) prepare Test Plan Document, Test Cases; (d) Code Walk through.

