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RESEARCH ARTICLE

REAL-TIME TRACKING FOR NON-BS6 CHASSIS: FINDING THE RIGHT MARKET FIT

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Abstract

This research paper addresses the critical challenge of tracking non-BS6 drive-away chassis, vehicles that lack On-Board Diagnostics (OBD) ports, license plates, and other conventional identifiers. These chassis, often in transit from manufacturing facilities to export ports, pose significant tracking difficulties due to the absence of built-in electronic systems. The objective of this study is to identify the most reliable, cost-effective, and operationally feasible tracking solution for such vehicles.Using a non-probability purposive sampling method, over 40 companies offering tracking technologies were initially identified. In-depth discussions were conducted with a shortlisted set of providers based on technical compatibility and operational capacity. The study critically analyzed both hardware-based GPS/GSM solutions and mobile SIM-based tracking alternatives, evaluating each against key parameters such as real-time visibility, reverse logistics, ease of deployment, and cost.Among the companies evaluated, some emerged as top candidates, offering practical and scalable rental-based GPS tracking solutions that eliminate the need for capital investment while ensuring real-time monitoring. The research concludes that rental-based GPS/GSM systems present the most effective model for tracking non-BS6 chassis during transit, balancing technological reliability with economic viability.

Introduction:-

In the context of vehicular emissions and manufacturing standards in India, BS6 (Bharat Stage VI) refers to the sixth and most stringent emission norm mandated by the Government of India to reduce air pollution. Vehicles that do not comply with this standard are classified as non-BS6 vehicles, and are typically older models or pre-registration units, such as drive-away chassis.

A chassis refers to the incomplete framework of a vehicle, consisting primarily of the engine, wheels, and transmission, but lacking critical components such as the vehicle body, license plate, and onboard electronics. Since these units are not fully assembled or registered, they lack essential tracking interfaces like OBD (On-Board Diagnostics) ports or telematics systems that are otherwise used in BS6-compliant vehicles. This makes real-time tracking during their transit particularly challenging, especially while transporting them from the manufacturing site to ports or dealerships. The absence of registration identifiers, electronic systems, and standard power sources limits

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the applicability of traditional GPS, RFID, or network-based tracking solutions.In the export industry, non-BS6 chassis are classified as high-value goods, and their loss during transit can result in substantial financial setbacks for companies. These chassis must be tracked from the manufacturing facility to the port. Given their value, real-time tracking during this interval is essential to prevent theft or misplacement.Various tracking technologies have been tested in such scenarios, including RFID-based systems, mobile SIM-based tracking, and LoRaWAN-enabled devices. Each of these comes with significant drawbacks: RFID, while cost-effective, does not offer real-time tracking, SIM-based tracking is heavily reliant on driver cooperation, and LoRaWAN, though functional, is not cost-efficient for large-scale deployment. As a result, these methods are not viable for reliably tracking non-BS6 chassis. The only robust and reliable solution is a GPS (Global Positioning System) /GSM (Global System for Mobile Communications) tracking system.

Global Positioning System (GPS): The Global Positioning System (GPS) is a satellite-based navigation system that allows users to find accurate location and time anywhere on Earth. It works by receiving signals from satellites and calculating the position of the GPS receiver. In vehicles, GPS helps track movement, routes, and speed in real time. This makes it very useful for monitoring and managing vehicles (Kaplan & Hegarty, 2017).Global System for Mobile Communication (GSM): The Global System for Mobile Communication (GSM) is a worldwide mobile network standard mainly used for calling and data transfer. In tracking systems, GSM is used to send the location data (collected from GPS) to a central server or user's device through mobile networks. This means even if the vehicle is far away, its location can be monitored remotely (Mouly & Pautet, 1992).

However, equipping every chassis' with such a device is economically unfeasible due to the associated costs of installation, inventory management, and reverse logistics. To address this challenge, this research explores a rent-based GPS/GSM tracking model, evaluating ways to optimize its implementation by partnering with companies that can absorb the additional operational burdens.

Objectives:-

- To identify and evaluate the critical factors involved in onboarding companies for tracking drive-away chassis.
- To conduct qualitative research to determine the most reliable and cost-effective provider of GPS/GSM tracking solutions for non-BS6 chassis.
- To assess and eliminate less efficient tracking methods unsuitable for this specific context.

Research questions:

- What are the key factors influencing the successful onboarding of companies for tracking drive-away chassis in the Indian automotive logistics context?
- Which GPS/GSM tracking solution providers offer the most reliable and cost-effective options for non-BS6 drive-away chassis tracking?
- What are the current limitations of alternative tracking methods (e.g., manual logs, SIM tracking), and why are they unsuitable for non-BS6 chassis?

Literature Review:-

Tracking systems for drive-away chassis that are partially built and transported without complete telematics infrastructure pose unique technological challenges. While traditional vehicle tracking solutions rely heavily on GPS, GSM, or RFID technologies, these methods assume that the vehicle is equipped with the necessary onboard devices. This review explores current technological frameworks, evaluating their feasibility for use in tracking drive-away chassis.Lee, Tewolde, and Kwon (2014) designed a GPS/GSM/GPRS-based vehicle tracking system using smartphone integration and cloud services. Their Internet of Things (IoT) approach enables real-time fleet monitoring but is most effective in vehicles with factory-installed modules, making it less suitable for chassis lacking such infrastructure.

Bhargavi et al. (2021) implemented a GPS-based tracking system for agricultural harvesters on rental, demonstrating low-cost tracking solutions adaptable for intermittent-use vehicles. Although intended for farm equipment, their work suggests potential applications in tracking chassis during temporary transport.Prajwal et al. (2022) reviewed LoRa-based technologies and highlighted their energy-efficient, long-range communication capabilities, which can be advantageous in low-infrastructure scenarios like chassis yards. This complements findings by Griese (2019), who compared LoRa and RFID systems for vehicle identification and concluded that LoRa performs well in

environments with limited bandwidth and infrastructure.Bapat and Nimbhorkar (2016) proposed a multilevel RFID-based tracking system, focusing on secure logistics and object monitoring. While RFID is limited by its dependency on fixed reader infrastructure, it remains useful for localized tracking, such as entry and exit of chassis in factory premises.

Kumar et al. (2021) developed an advanced GPS-GSM-based system to detect overspeeding and accidents. Though primarily designed for fully operational vehicles, the modular nature of their solution could be adapted for temporary tracking units on drive-away chassis.Prasanna and Hemalatha (2012) proposed an integrated RFID, GPS, and GSM-based logistics system for vehicle load balancing and tracking. Their centralized coordination model provides valuable insight into managing the movement of multiple units across the supply chain, such as chassis transportation routes.The Ministry of Road Transport and Highways (2020) issued the AIS-137 (Part 4) document related to Bharat Stage-VI emission norms, which emphasizes the growing need for digital traceability and real-time data management. Although these norms apply to fully assembled vehicles, the pressure for emission compliance necessitates early tracking and documentation across the vehicle life cycle including the chassis phase.

Research Gaps and Future Directions:-
Most vehicle tracking systems assume the presence of a built-in power supply, onboard sensors, or a GPS module. Drive-away chassis typically lack these features, creating a gap in existing literature and practice. Technologies like LoRa and RFID, which function on external, low-cost modules, show potential but are underutilized in the Indian automotive logistics sector.Further research is required to develop modular, attachable tracking systems that can be deployed without depending on vehicle-integrated telematics. Solutions may include LoRa-based GPS tags, RFID yard systems, or QR-code-based visual tracking mechanisms, all of which could provide cost-effective, scalable solutions for this overlooked stage of the vehicle supply chain.

Methodology:-
This study employs a qualitative and descriptive research design, supplemented with a systematic quantitative evaluation framework to ensure rigor. The primary objective is to identify and evaluate alternative tracking solutions for non-BS6 vehiclesQualitative methods were chosen due to the exploratory nature of the research, which requires in-depth understanding of technical feasibility, operational workflows, and stakeholder perspectives. To enhance transparency and objectivity, a multi-criteria scoring and weighting framework was implemented to assess solutions.

Data Collection:-
Data were collected from primary and secondary sources:

- **Primary Data:**
  - Collected from 40 stakeholders across OEMs, solution providers, and logistics partners. These 40 responses represent the actual population of stakeholders who responded substantively to outreach efforts extended to all identified companies in the domain.

  - **Methods included:**

1. Email correspondence to gather preliminary insights.
2. Individual interviews with key personnel for technical, operational, and commercial understanding
3. Collection of commercial and technical proposals for detailed cost-benefit and feasibility analysis.
4. Structured surveys to identify hidden constraints in real-world implementation (connectivity, privacy, operational bottlenecks).

- **Secondary Data:**
  - Drawn from white papers, industry case studies, official reports, and academic literature to provide context, triangulate findings, and validate primary data insights.

Data collection occurred over a three-month period (April–June 2025), with secondary data reviewed concurrently to inform iterative refinement of evaluation criteria.

Sampling Strategy:
A purposive non-probability sampling approach was applied because the study required input from stakeholders with direct technical and operational knowledge of vehicle tracking systems. Random sampling was inappropriate due to the specialized expertise needed.

While 40 stakeholders responded, only 5 companies were selected for detailed evaluation, as they:

1. Provided full disclosure of both commercial and technical proposals.
2. Offered solutions that aligned with the objectives of the study.
3. Demonstrated potential for real-world feasibility and scalability.

This focused approach allowed for high-quality, in-depth evaluation, rather than superficial assessment of all respondents.

Evaluation Framework:

A multi-criteria evaluation framework was developed to assess each of the 5 selected solutions systematically. Evaluation criteria were grouped into four categories:

1. Technical Capabilities

- Plug & Play / Magnetic Installation
- Real-Time Tracking Interval
- Dashboard Access (Web/App)
- Integration with Existing Systems
- Historical Data Access
- User Roles & Access Control

2. Operational Capabilities

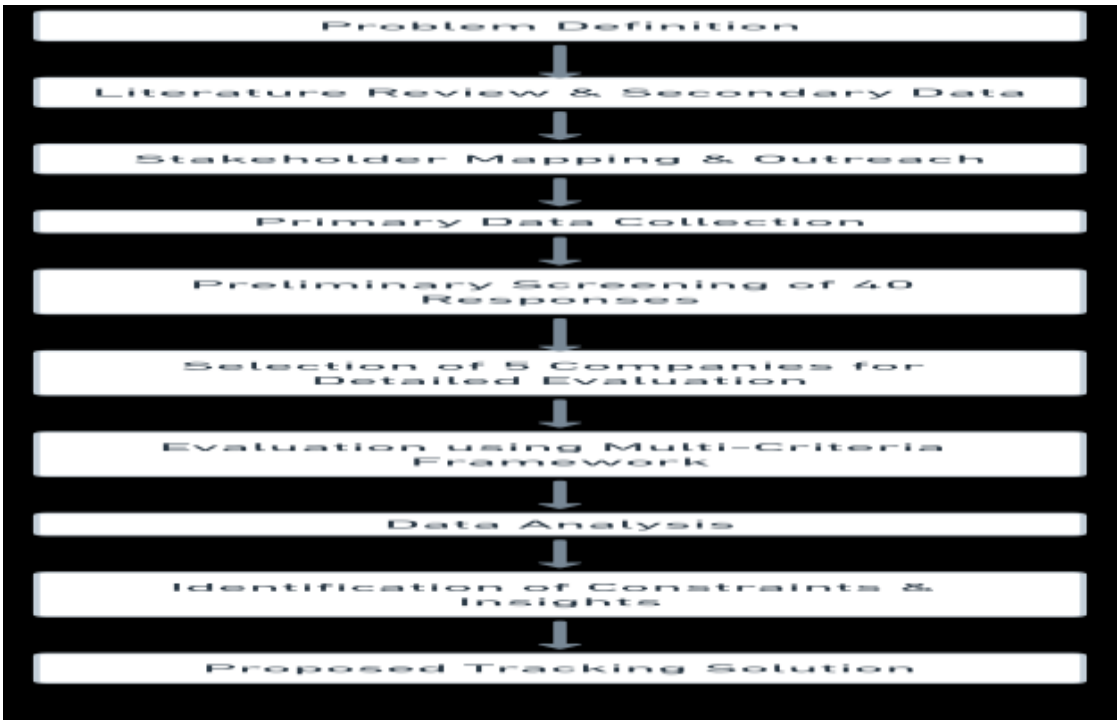
- Post-Use Pickups (Ports)
- Reverse Logistics Capability
- Field Support (Breakdowns)

3. Financial Considerations

- Pricing Flexibility
- Hidden Charges

4. After-Sales Support

- Repair and Replacement Process
- Support Channels



Results:-

In the search for effective vehicle tracking solutions, various technologies were examined based on feasibility, cost, and reliability such asSIM-based tracking, LoRaWAN, RFID, Bluetooth, mobile-based applications, and telematics integrations.

1.SIM-Based Tracking:-

Some stakeholders suggest tracking via the driver's mobile SIM card. While cost-effective and easy to implement, this method relies heavily on the driver keeping their phone active with location services enabled. It is also vulnerable to manipulation as drivers may switch off phones, remove SIMs, or keep them stationary to mislead tracking. Furthermore, network blackspots can affect data accuracy, making this method unreliable for critical logistics. One famous company providing this service with online mapping would be Freight Tiger.

2.LoRaWAN(Long Range Wide Area Network):-

LoRaWAN is highlighted for its low power consumption and long-range communication. However, its dependency on a custom network of gateways poses a significant limitation. It lacks widespread coverage and requires heavy initial investment to build and maintain infrastructure. It isespecially impractical in remote or constantly changing routes. Additionally, LoRaWAN's low data bandwidth makes it unsuitable for real-time, high-frequency tracking.

3.RFID(Radio Frequency Identification):-

RFID is useful in fixed-location tracking scenarios, such as recording vehicle entry/exit at gates or checkpoints. Passive RFID tags are low-cost and maintenance-free, but they do not transmit real-time location data. Active RFID options exist but are still limited to short-range tracking. RFID works well when continuous tracking is not a requirement and occasional position updates at defined nodes are sufficient.

4.Bluetooth-Based Tracking:-

Bluetooth tags were considered for short-range identification. However, their limited range and reliance on paired devices (e.g., a mobile phone or Bluetooth beacon receiver) makes them unsuitable for vehicle-level tracking over wide areas. This solution is more viable in indoor environments like warehouses rather than on-road logistics.

5.Mobile Application-Based Tracking:-

Tracking apps installed on drivers' smartphones can provide real-time data using phone GPS. While user-friendly and scalable, the drawbacks are similar to SIM-based tracking, with their being a dependency on the driver's behavior, battery consumption, and possible app termination or background restrictions that stop location sharing.

Based on these evaluations, a GPS-based tracking system emerged as the most reliable and scalable solution. It provides independent, real-time data that is not affected by driver compliance or local infrastructure gaps. Magnetic GPS devices, in particular, are suitable as they require no complex installation or special ports and can be directly attached to the vehicle's chassis. They ensure continuous visibility, which is vital for regulatory compliance, security, and operational efficiency. However, equipping every vehicle with such devices, along with managing installation and retrieval (reverse logistics), can be costly and add significant operational responsibilities. These limitations have been further examined in research.

The possibility of partnering with companies that offer GPS devices on a rental basis over a defining period was also explored. Renting introduces challenges such as inventory management, installation complexities, and reverse logistics. Companies which were capable of handling these aspects were reached out to. Among these, only those which addressed operational concerns and provided comprehensive solutions to the problem were shortlisted.

Preliminary background checks were conducted to assess the eligibility of potential service providers. Companies that met the essential operational and technical criteria were shortlisted for further engagement through interviews.

The key operational factors which were evaluated included:

- Capability to supply tracking devices at scale
- Availability of return and replacement processes
- Support for real-time tracking at regular intervals
- Provision for reverse logistics
- Field support for device breakdowns
- Pricing flexibility
- Battery life of the device

The analysis revealed that although many companies claim to offer end-to-end tracking solutions, only a limited number can do so efficiently and affordably. Cost structures varied significantly, typically based on either a per-trip or per-device pricing model. A consistent challenge across the market was identifying a solution that offered reverse logistics, support, inventory visibility, and app integration within a ₹100/trip budget.Standout CompaniesFreight Tiger (For RFID and SIM based tracking): For companies exploring the implementation of RFID or driver SIM-based tracking solutions, Freight Tiger emerges as a leading Indian logistics technology provider. Known for its user-friendly interface and powerful data capabilities, Freight Tiger offers an integrated logistics platform that stands out for its accessibility, affordability, and intelligence.

Key features of the Freight Tiger system include:

- Multi-Modal Tracking: Utilizes driver SIM tracking as the primary method. In cases where SIM-based tracking is unavailable, the system seamlessly switches to RFID-based tracking, ensuring continuous visibility.
- Intelligent Mapping & UI
- Affordable & Scalable: Their pricing model is structured to be cost-effective for both large enterprises and small to mid-sized businesses,making advanced supply chain visibility accessible to all.
- Advanced Analytics available in the system
- End-to-End Visibility

Blackbox: BlackBox GPS Technology (OPC) Pvt. Ltd. offers the TM 11 GPS tracking system designed specifically for non-BS6 vehicles. The device provides a standalone, hardware-based tracking solution ideal for fleets that cannot support OBD-II or CAN-based technologies, such as drive-away chassis or older commercial vehicles. It is positioned as an affordable and technically reliable solution for real-time location tracking and fleet visibility.

Key Features and Capabilities:-

- Real-time GPS tracking, route playback, geofence alerts,provides continuous location data to ensure live tracking and improved fleet monitoring.

- **Multiple Reports available on the platform**

- **Flexible Commercial Models**

- Outright Purchase: ₹2,950 per device (₹2,500 + 18% GST) with a one-year warranty. Annual subscription from the second year costs ₹2,832 (₹2,400 + GST), and annual maintenance is ₹590 (₹500 + GST).
- Per-Trip Model: ₹354 per trip (₹300 + 18% GST), covering device usage, SIM/data hosting, access to web and mobile apps,and reverse logistics.

- **Reverse Logistics Support**
  Includes device removal and redeployment services when vehicles exit the fleet, ensuring data continuity and simplified inventory management. This feature is especially useful under the per-trip pricing model.

- **Web Dashboard and Mobile Application Access**
  The tracking platform is accessible through a web-based dashboard and dedicated mobile applications for Android and iOS, offering operational flexibility.

- **On-Site Installation and Warranty**
  On-site installation is included in the offering, with a one-year warranty covering manufacturing defects.

- **Subscription Renewal Support**
  Automated reminders are issued 15 days before subscription expiry, ensuring consistent service with minimal administrative oversight.

Limitations and Drawbacks: Despite its strong functionality and affordable pricing, the BlackBox TM 11 device has several notable drawbacks:

- **Outdated User Interface**
  The UI of both the web portal and mobile apps is dated and lacks responsiveness. Operations may be slower during real-time tracking,which could hinder user experience.

- **Steep Learning Curve**

Navigating the system and extracting actionable insights requires familiarity with the interface. Without additional onboarding or training, users may not fully benefit from the platform's capabilities.

Vamosys: Vamosys offers a rental-based telematics solution tailored for enterprises seeking a scalable and cost-conscious fleet tracking model. Vamosys operates on a per-device rental structure, which makes it suitable for companies which prefer consistent monthly costs and longer-term deployments.Their offering includes essential tracking features, wide platform compatibility, and operational support for fleet management across regions.

Key Features and Capabilities:

- **Real-Time GPS Tracking**
  The system enables live vehicle tracking, enhancing route transparency and operational monitoring across all fleet sizes.
- **Reverse Logistics Support**
  Vamosys includes device retrieval and redeployment services in its offering. This makes the solution logistically feasible for dynamic fleets where vehicles are frequently replaced or moved.
- **Route-Based Features**
  The platform offers route planning and optimization tools, including stoppage reports and deviation alerts, which support efficient operations and timely deliveries.

- **Mobile Application and Web Platform Access**
  Accessible via Android and iOS apps as well as a browser-based dashboard, Vamosys allows users to manage vehicle data remotely.

- **API Integration and Compatibility**
  The system is API-friendly, allowing seamless integration with enterprise-level software systems. There are no disclosed customization or integration fees, making it attractive for businesses with complex system requirements.

- **National and Global Support Network:-**
  Vamosys offers robust service support across India and in select global regions, ensuring continuity of operations even during inter-state or international transport.

Limitations and Drawbacks:-

While Vamosys provides a reliable and functional telematics package, the following limitations should be considered:

- **Client-Managed Inventory and Charging:-**
  Device storage, charging, and maintenance logistics are handled by the client, adding a layer of operational responsibility,especially for large-scale deployments or third-party fleets.

- **Traditional Deployment Approach:-**

The offering leans toward a more conventional telematics rental structure. While stable and predictable, it lacks some of the pay-as-you-go flexibility seen in newer, event-driven tracking models.Vamosys provides a robust and budget-conscious solutionIt offers all key telematics features such as real-time tracking, reverse logistics, and API compatibility, making it well-suited for long-term deployments. While it may not be ideal for highly flexible or short-term operations, its strong backend support, integration capabilities, and regional service coverage make it a strong contender for enterprise-level logistics tracking.

iTriangle: iTriangle offers a rental-based model and is a well-established hardware OEM with over 16 years of experience and more than 1.5 million devices deployed. While it provides real-time tracking and trip history, it does not include reverse logistics by default and requires integration support is available, but it might have extra charges.

Fleetx: Fleetx is an enterprise-level provider offering robust dashboards, analytics, and integration support. However, it might require a higher CAPEX (Capital Expenditure). While scalable and feature-rich, it might not fit the cost or flexibility goals of the project unless major services like logistics are excluded.

Discussion and Analysis:-

GPS/GSM based hardware tracking is foolproof for those who seek operationally independent solutions which are reliable. Plug-and-play or magnetic devices are ideal for temporary use, especially if reverse logistics is streamlined. A low-cost, viable option for vehicle tracking is SIM-based tracking, where the drivers' phone is tracked is one of the most cost-effective mediums. Freight Tiger can be considered a suitable provider for this method of tracking. This method has its downsides like requisite explicit consent, interruption of tracking due to various reasons and failed tracking in low connectivity regions.

To ensure seamless execution, it is critical that the chosen service provider supports:

- Inventory management and battery monitoring
- Return logistics (both pickup and courier return)
- No hidden costs or additional implementation fees
- A functional web and mobile portal for real-time visibility

Among evaluated providers, Blackbox emerges as a strong candidate. While its user interface may not be as advanced as that of Fleetx or Roambee, it offers exceptional cost-efficiency and end-to-end operational coverage. Vamosys is another suitable option, offering a comprehensive platform with strong tracking capabilities. However, it operates on a per-device rental model, which may not be ideal for certain clients.

Comparative Evaluation

Feature / Criteria	Freight Tiger (SIM/RFID)	BlackBox (GPS/GSM)	Vamosys (GPS Rental)	iTriangle (GPS Rental)	Fleetx (Enterprise GPS)
Primary Tracking Method	Driver SIM (fallback: RFID)	GPS/GSM device (TM11)	GPS/GSM rental device	GPS/GSM rental device	GPS/GSM advanced system
Pricing Model	Platform subscription	₹354/trip or ₹2,950/device (1st year)	Monthly rental per device	Monthly rental	Higher CAPEX; enterprise-scale pricing
Reverse Logistics Support	Not included	Included (pickup + redeployment)	Included	Not included by default	Available (varies by package)
User Interface/UX	Advanced, clean, user-friendly	Functional but outdated	Clean, functional UI	Basic interface	Enterprise-grade UI
Analytics & Reports	Advanced analytics dashboard	Multiple basic reports	Route reports, stoppage, deviation alerts	Standard trip history	Advanced analytics, alerting, and AI support
Installation & Setup	No hardware required	On-site installation included	Both plug-and-play or installed devices available	Installed devices	Requires full fleet integration
Integration/API Support	API Available	Limited	API integration included	Available (may incur cost)	Full API suite available
Network Dependency	High (SIM-based tracking)	Low,independent of driver, mobile, or SIM	Low	Low	Low
Battery Monitoring/Inventory Mgmt	Not applicable	Included	Client-managed	Client-managed	Included
Strengths	Very low cost; accessible	Cost-efficient; per-trip; reverse logistics	Predictable cost; API-ready; good support	Proven OEM; mature hardware	Feature-rich; strong dashboards

Limitations	Dependent on driver consent & phone use	Outdated UI; learning curve	Client manages charging & storage	No reverse logistics; may incur extra costs	Expensive; overbuilt for temporary use
Best For	Low-cost operations with known drivers	Flexible, short-term, and low-CAPEX tracking	Long-term deployments with tech staff	OEM buyers; long-term projects	Large enterprises with integrated logistics

Conclusion:-

Through this study, we identified that SIM-based solutions offer a low-cost alternative. However they introduce significant operational dependencies and reliability issues, particularly around driver consent, network availability, and device continuity.Post the evaluation ofa range of tracking technologies and providers, GPS/GSM-based hardware emerged as the most viable solution for high-value, short-term transit of non-BS6 chassis. However, direct ownership of these devices is capital-intensive and operationally cumbersome due to the demands of installation, retrieval, and inventory management. Therefore there was an exploration of rental-based GPS tracking models, which struck a balance between operational efficiency and financial feasibility.

Our qualitative analysis revealed that only a select few providers,most notably Blackbox and Vamosys were able to deliver robust, cost-efficient, and scalable tracking services aligned with the needs of this segment. Blackbox stood out for its pay-per-trip model with zero CAPEX and end-to-end service coverage including reverse logistics. Vamosys, though based on a per-device rental model, also offered comprehensive support and system reliability.
The findings underscore the importance of choosing a tracking partner not only based on technological capability but also on service ecosystem support, such as battery management, reverse logistics, and app integration. The successful implementation of such solutions could significantly reduce transit risks, improve accountability, and ultimately protect businesses from the financial consequences of asset loss during the export process.This research provides a tested and field-relevant model for companies looking to implement real-time tracking for non-BS6 chassis. It covers what could be the ideal solution for tracking in the current technological and regulatory landscape, while explaining the various options along with their setbacks.

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