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## **Review Article**





# Enhancing DVIR with AI-Powered Defect Tracking and Management

#### Sahil Nyati

Director Engineering, Maven Machines, USA

#### \*Corresponding author

Sahil Nyati, Director Engineering, Maven Machines, USA.

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#### Introduction

This research paper proposes an enhanced Digital Vehicle Inspection Report (DVIR) system that leverages artificial intelligence (AI) to revolutionize defect tracking and management in fleet operations. The system aims to support associating and tracking defects on a per-asset basis and individually handling these defects with advanced AI capabilities.

#### Goals

The proposed solution to enhance the Digital Vehicle Inspection Report (DVIR) product revolves around integrating advanced artificial intelligence (AI) capabilities. This expansion focuses on a detailed breakdown of how AI can be incorporated into various aspects of the DVIR system to improve efficiency, accuracy, and compliance.

#### **Active Assets Management**

#### **AI-Driven Asset Status Classification**

- Implement AI algorithms to classify the status of assets (In Service, Out of Service) based on their current condition, historical data, and detected defects.
- Utilize predictive analytics to forecast potential issues, enabling proactive maintenance and reducing unexpected down- times.

#### **Real-Time Asset Monitoring**

- Integrate sensors and IoT devices to gather real-time data from assets.
- AI models analyze this data stream to detect anomalies and update asset status dynamically.

#### **Inspection Reports Enhancement Automated Defect Identification**

- Use AI to automatically identify and log defects during inspections.
- Machine learning models analyze images, sensor data, and driver inputs to detect and categorize defects accurately.

#### **Historical Data Integration**

- AI algorithms assess historical inspection data to identify recurring issues or patterns in defects.
- Provide drivers and managers with insights into asset health trends over time.

#### Defects Management Smart Defect Tagging

- AI categorizes defects based on severity and type, specific to each asset class (e.g., Trailer Defect List vs Tractor Defect List).
- Defect tagging assists in prioritizing maintenance tasks and resource allocation.

#### **Defect Status Lifecycle Management**

- Implement AI to manage the lifecycle of each defect, from identification to resolution.
- Predictive models suggest the most efficient resolution paths and estimate repair times.

#### **User Flow Optimization**

#### **AI-Assisted Report Generation**

- Integrate AI to simplify the report creation process, recommending assets for inspection based on their status and usage patterns.
- Natural language processing (NLP) can be used to interpret driver notes and automatically populate relevant fields in the report.

#### **Defect Resolution Guidance**

- AI provides step-by-step guidance for drivers to resolve or verify defects, based on similar past instances and manufacturer guidelines.
- Interactive AI tools can be developed to assist drivers in realtime during the inspection process.

#### Enhanced AI Features for Drivers and Managers AI-Enhanced Driver Interface

- AI-powered search and filter options for drivers to easily access past reports and active assets.
- Recommendation engine to highlight assets needing immediate attention based on their defect status.

#### Managerial AI Dashboards

- Develop AI-driven dashboards for managers, showcasing realtime fleet status, defect resolution progress, and compliance reports.
- Implement anomaly detection systems to alert managers about critical issues in the fleet.

#### **Regulatory Compliance and AI**

- Ensure AI models are trained in line with industry regulations and safety standards.
- Automatic documentation and reporting features to maintain regulatory compliance, especially for critical defects that could render an asset non-compliant.

By infusing AI into the DVIR system, the solution not only enhances the efficiency of asset management and defect handling but also brings a new level of intelligence and foresight into fleet operations. It represents a significant step towards a more datadriven, predictive approach to vehicle inspection and maintenance in the logistics and transportation industry.

#### **User Flow Enhancement With AI**

Incorporating AI into the DVIR system revolutionizes the user experience by streamlining workflows, enhancing decisionmaking, and automating defect management. Below is an expanded overview of the enhanced user flow, supported by AI, with corresponding database design, pseudocode, and flowcharts.

#### **AI-Assisted Report Initialization**

- Flow: When creating a new report, the AI suggests relevant assets based on historical data and current conditions.
- **Database:** 'reports' table to store report metadata; 'assets' table linked to 'reports' for asset-report association.
- **Pseudocode:** ""python def initialize\_report(user\_id, current\_time): assets = AI\_model.recommend\_assets(user\_id, cur-rent\_time) report\_id = create\_new\_report(user\_id, assets, cur-rent\_time) return report\_id ""

#### **Dynamic Defect Identification and Categorization**

- Flow: As defects are logged, AI categorizes and prioritizes them based on severity and asset type.
- **Database:** 'defects' table with fields for 'category', 'severity', 'status', and foreign key to 'assets'.
- **Pseudocode:** "python

def log\_defect(report\_id, asset\_id, defect\_data):

category, severity = AI\_model.analyze\_defect(defect\_data)

defect\_id = add\_defect\_to\_database(report\_id, asset\_id, category, severity) update\_asset\_status(asset\_id, severity) return defect\_id ""

#### **Real-Time Asset Status Update**

- Flow: Asset status is updated in real-time based on defect severity and AI predictions.
- Database: 'asset status' field in the 'assets' table.
- **Pseudocode:** "python

def update\_asset\_status(asset\_id, severity):

#### Flowcharts

- Report Initialization Flowchart Start -> User initiates report creation -> AI suggests assets -> User confirms assets
- End.
- Defect Logging Flowchart Start -> User logs defect -> AI categorizes defect -> Defect added to report -> AI updates asset status -> End.

#### **Database Schema**

#### Tables

- 'reports': Fields include 'report\_id', 'user\_id', 'timestamp', etc.
- 'assets': Fields include 'asset\_id', 'asset\_type', 'status', etc.
- 'defects': Fields include 'defect\_id', 'report\_id', 'as- set\_id', 'category', 'severity', 'status', etc.

#### Relationships

- 'reports' to 'assets': One-to-many, as each report can include multiple assets.
- 'assets' to 'defects': One-to-many, as each asset can have multiple defects.

#### Key User Stories Supported by AI

Enhancing the DVIR system with AI support greatly improves the user experience for both drivers and managers. Below, we explore key user stories that are enhanced by AI, along with detailed code examples illustrating how these functionalities can be implemented.

#### **User Stories**

#### **Driver Access to DVIR Based on Permissions**

- Story: Drivers can access the DVIR system only if they have the appropriate permissions.
- **Implementation:** Use an authentication and authorization system to control access.
- Code:
- "'python

def access\_dvir(user\_id):

if has\_permission(user\_id, "DVIR\_ACCESS"): dvir\_reports = get\_dvir\_reports(user\_id)

return dvir reports else:

raise AccessDeniedException("User lacks DVIR access permission.")

#### **Selecting Vehicles and Viewing Past Reports**

- **Story:** Drivers select vehicles and view past reports for those vehicles.
- **Implementation:** Fetch vehicle data and related reports from the database.
- Code:

### "'sql

SELECT \* FROM reports WHERE vehicle\_id = ? AND report\_ date >= ?

#### "python

def get\_past\_reports(vehicle\_id, days=8): past\_date = get\_date\_ days\_ago(days)

reports = execute\_sql\_query("SELECT \* FROM reports WHERE vehicle\_id = ? AND report\_date >= ?", [vehicle\_id, past\_date]) return reports "'



Figure 1

#### **Creating New Inspection Reports**

- Story: Drivers add new reports, selecting assets, date/time, and other details.
- **Implementation:** Implement a report creation interface that feeds data into the AI model for asset recommendation.
- Code:

"'python

def create\_new\_report(user\_id, selected\_assets, re- port\_date, report\_type, location):

recommended\_assets = AI\_model.recommend\_assets(user\_id, selected\_assets)

report\_id = insert\_new\_report\_into\_db(user\_id, recom- mended\_ assets, report\_date, report\_type, location) return report\_id ""

#### Adding and Resolving Defects for Assets

- Story: Drivers can add new defects to assets and resolve active defects.
- **Implementation:** Use forms to capture defect details and update the asset's status based on AI recommendations.
- Code:

"python

def add\_defect\_to\_asset(report\_id, asset\_id, de-fect\_description): defect\_category = AI\_model.predict\_defect\_category(defect\_ description)

defect\_id = insert\_defect\_into\_db(report\_id, asset\_id, defect\_ category, defect\_description)

 $update\_asset\_status\_based\_on\_defect(asset\_id, defect\_id) \ return \ defect\_id$ 

def resolve\_defect(defect\_id, resolution\_details): update\_defect\_ status\_in\_db(defect\_id, "Resolved", resolution\_details) ""

#### Manager Oversight of Defect Resolution

- Story: Managers audit and certify the resolution of defects.
- **Implementation:** Implement managerial functionalities for reviewing and updating the status of defects.
- Code:

"python

def manager\_resolve\_defect(defect\_id, resolution\_details, manager\_id):

if has\_permission(manager\_id, "MANAGE\_DEFECTS"): update\_ defect\_status\_in\_db(defect\_id, "Resolved by Man-

ager", resolution\_details) else:

raise AccessDeniedException("User lacks defect manage- ment permission.")

#### Prospects

#### **Advanced Defect Detection**

Integrate more sophisticated AI models for real-time defect detection using image recognition and sensor data.

#### **Predictive Maintenance**

Leverage AI to predict future maintenance needs, preventing issues before they occur:

#### **User Experience Personalization**

Tailor the DVIR interface and recommendations based on individual user behaviors and preferences.

By adopting AI-driven functionalities, the DVIR system becomes not only a tool for compliance but also a strategic asset in fleet management, driving efficiency, safety, and reliability in fleet operations.



Figure 2

#### Conclusion

The integration of Artificial Intelligence (AI) into the Digital Vehicle Inspection Report (DVIR) system represents a transformative approach in fleet management and vehicle inspection processes. This conclusion re-emphasizes the benefits, implications, and future potential of this AI-enhanced system.

### Key Benefits Reiterated

#### Precision in Defect Tracking and Resolution

• The AI-enhanced DVIR system brings unparalleled accuracy in identifying, categorizing, and suggesting remedies for defects on a per-asset basis, leading to more precise maintenance interventions.

#### **Efficiency in Fleet Management**

 By automating and optimizing various aspects of the DVIR process, the system significantly reduces the time and effort required for inspections, allowing fleet managers and drivers to focus on more critical tasks.

#### **Proactive Maintenance and Downtime Reduction**

• AI's predictive capabilities enable early detection of potential issues, facilitating proactive maintenance, reducing unexpected breakdowns, and minimizing vehicle downtime.

#### **Regulatory Compliance Assurance**

The system's ability to adhere to and automate compliancerelated aspects ensures that fleet operations stay within regulatory boundaries, reducing the risk of violations and penalties. Citation: Sahil Nyati (2022) Enhancing DVIR with AI-Powered Defect Tracking and Management. Journal of Artificial Intelligence & Cloud Computing. SRC/JAICC-222. DOI: doi.org/10.47363/JAICC/2022(1)207

#### **Enhanced Decision-Making**

• With AI-driven insights and real-time data analysis, fleet managers are equipped with actionable information to make informed decisions regarding asset utilization, maintenance scheduling, and overall fleet operations.

#### **Implications for Fleet Operations**

- The adoption of this AI-enhanced DVIR system marks a shift towards data-driven and intelligent fleet management.
- It signifies a move away from reactive maintenance strategies to more predictive and preventive approaches.
- The system's ability to adapt to individual asset needs and user behaviors presents a personalized approach to fleet management.

#### Prospects and Developments Continued AI Evolution

 Ongoing advancements in AI and machine learning promise even more sophisticated analysis and predictive capabilities, further enhancing the DVIR system.

#### Integration with Emerging Technologies

• Potential integration with IoT, telematics, and advanced sensor technology could provide deeper insights into asset health and operational efficiency.

#### **Expansion and Scalability**

The system's design allows for scalability and adaptability, making it suitable for diverse fleet sizes and types, including potential applications in other transportation sectors.

#### **User Experience Enhancement**

Continued refinement of the user interface, driven by user feedback and AI analytics, will make the system even more intuitive and user-friendly.

Incorporating AI into the DVIR system is not just an upgrade in technology; it's a strategic enhancement that propels fleet management into a new era of efficiency, reliability and intelligence. As this technology evolves, it will continue to reshape how fleet operations are conducted, setting new standards in vehicle maintenance, safety, and operational excellence [1-3].



Figure 3



Figure 4

# Defect.oggingFlowchant Start User logs defect Al categorizes defect Defect.added to report Al updates asset status End



#### References

- 1. Artificial Intelligence in Fleet Management Systems. Journal of Transportation Technologies.
- 2. Machine Learning Techniques for Vehicle Inspection. IEEE Transactions on Intelligent Transportation Systems.
- 3. Smith J, Clark R. Artificial Intelligence for Autonomous Networks.

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