Intelligent rail yards:

Fast-track to future-ready operations

Abstract

Changing business model, operational inefficiencies and consolidation initiatives have resulted in the shutting down of rail yards across North America and Europe. This has further led to pressure on remaining yards to perform better while physical rail infrastructure remains largely unchanged.

Modernization is critical for the remaining rail yards to perform efficiently. It is more cost efficient to improve existing rail yards than to build new, modern sophisticated ones. While the rest of the rail ecosystem comprising manufacturing, infrastructure management, and passenger and freight operations are on their digital-transformation journeys, rail yards seem to be lagging in pace. This paper focuses on how rail yards can gain efficiencies and face up to the challenges posed by the rest of the ecosystem, by adopting increased digitalization of existing processes and modernizing hardware. Various stakeholders including CXOs and staff such as yard masters and asset inspectors use different indicators (KPIs) to measure yard performance. These KPIs also vary at different levels but generally include reliability, safety, flexibility, visibility, and cost effectiveness.

Rail Yards: Addressing internal and external challenges

Rail yards play an important role in the overall value chain of passenger and freight transportation; they are a complex series of railroad tracks acting as hubs for operations including sorting, inspecting and repairing wagons, and fueling. Delays caused in activities in yards directly impact operations of the mainline network.

Typically, railway operating companies and rail yards are responsible for managing the timely movement of cars or wagons. Factors including non-availability of mainline tracks, discrepancies in documentation, defective wagons and limited track capacity cause delays in train arrivals and departures. Delays in departures lead to congestion in rail yards leads to rescheduling of traffic on mainline networks, and the cycle goes on (Figure 1) activities.

Figure 1: A typical sequence of events happening in rail yards resulting in delays in train arrivals and departures

Based on our experience, train wagons spend more than 50% of their lifetime idling, waiting to be scheduled. This also impacts utilization of resources such as locomotives, shunting operations, fuel and manpower. In addition, wagons found to be defective are usually taken out to repair areas and it is not uncommon for those to be lost or forgotten in rail yards. On the other hand, most asset inspections and shunting operations involve human intervention. This requires staff to be on track or near moving assets, increasing safety risks.

The lag in technology adoption

Leveraging digital tools and cutting-edge technologies including artificial intelligence (AI) and the internet of things (IoT) can help rail yards to overcome the many challenges they face. However, they seem to lag behind the rest of the players in the rail ecosystem when it comes to technology adoption. For instance, all the rail routes in USA became PTC compliant (positive train control) by the end of 2020 . Similarly, the European Union is supporting initiatives such as European Train Control System and European Rail Traffic Management System to help bring in more automation and standardization across various countries. These initiatives across North America and Europe involve the adoption of technologies to reduce human intervention by integrating numerous components across telecommunication spectrum such as GPS, wifi, cellular technology and various types of sensors deployed on train network. Rail yards are also in need of a similar concerted and integrated approach to improve efficiencies.

Tackling Challenges: A Multidimensional Approach

Rail yards may benefit by adopting a multidimensional approach to tackle the challenges they face: planning operations more efficiently and automating asset inspections. The main objective is to reduce system dwell time and minimize manual intervention to improve efficiencies.

Using optimization algorithms for planning operations

Freight and passenger operators have to work towards optimum utilization of resources and avoid delays. Delay in any single activity (Figure 2) derails the overall train schedule.

| Wait at Arrival Track | → | Inspection Documentation | → | Classification Operations | → | Couple & Pull Wagons | → | Inspection/ Documentation | → | To Departure Track |

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Figure 2: Flow of Activities in Rail Yards

By planning related tasks ahead of schedule, operators can make sure their wagons are kept idle for lesser amounts of time. Better integration with partners for proper block sequencing at the source (starting location of train) can help plan the classification operations with respect to train departure schedules and also yard-level resource allocation such as locomotive and yard staff.

Organizations can leverage operations research (OR) optimization algorithms such as linear programming and OR-based mathematical solvers for efficient planning of wagon block and break operations, thus boosting efficiency at the rail yard and on the mainline network. Real-time track assignment is also a way to tackle delays. However, this needs complex mathematical models as a majority of train schedules are assigned reasonably in advance and last-minute changes even in a small percentage of schedules has a direct impact on multiple related operations.

Augmenting infrastructure capabilities

In order to improve efficiencies, operators will need to replace manual asset inspection of wagons and components with machine-vision-based solutions. For instance, organizations can implement high-speed cameras and video streams backed by AI and vision systems at yard arrival and departure tracks to record the condition of wagons and their components at large yards. The four basic components of machine vision applications are inspection, gauging, guidance and identification. While this process reduces human intervention, it also eases up and automates the documentation process.

Similarly, radio frequency identification (RFID) sensors, optical character recognition (OCR) readers and geographic information system (GIS)-based mapping solutions can help in keeping track of the location of wagons whenever they enter or leave yards. This can improve the planning process for train assembly by quickly locating wagons within the yard. At the same time, shunting operations can be managed remotely by deploying solutions using high-resolution cameras, and IoT sensors combined with AI and deep learning to perform shunting operations. This can help to reduce the movement of staff near tracks, thus increasing overall asset and personnel safety.

Digitalizing the documentation process

Digitalizing the documentation process is another key component crucial to closing the loop in the IT modernization cycle of rail yards. Documentation processes vary across yards and they are subject to the maturity of IT systems and the flexibility with which information is integrated from external parties. Yards that continue to use manual documentation for recording of defects and issuing fitness certificates can digitize the asset-inspection process. Documentation applications installed on tablets, PCs, smart phones or hand-held devices can help in recording the asset condition in digital form, along with images. Information recorded using such mobile applications can be transmitted to relevant enterprise systems for subsequent actions such as asset repair or placing the order for spare parts based on inventory condition. In some cases, wagons taken on lease would require approval from the asset owner for repair work; digitally recording defects can help in expediting information exchange with the asset owner.
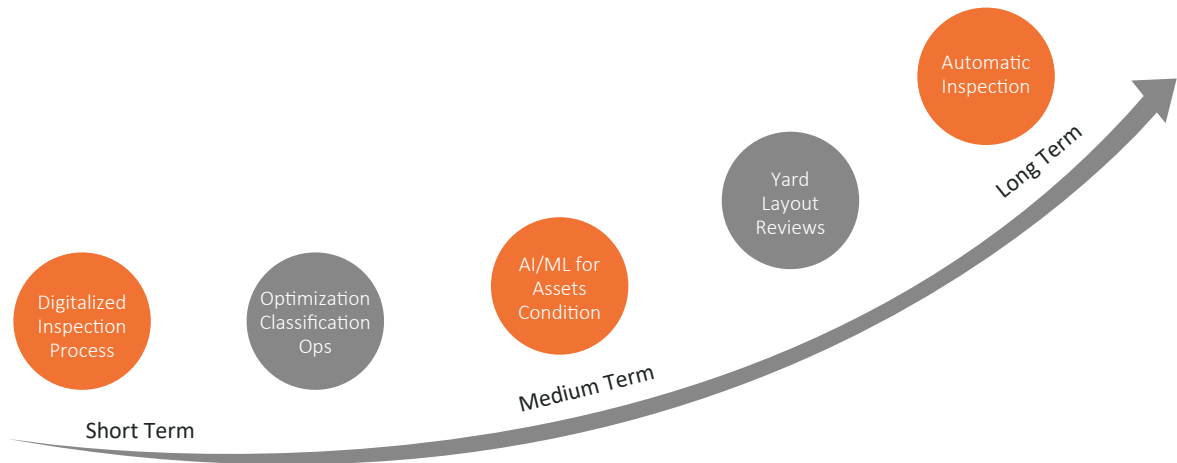

Figure 3: Modernization Roadmap for Rail Yards.

Building intelligent rail yards

Future rail yards can bring in efficiencies by implementing proposed changes and charting out operational, tactical and strategic goals over time-from short to medium and long term (Figure 3). Logistics and distribution supply chains are already leveraging technologies such as big data and analytics to improve tracking, and analyzing inventory through object identification, real-time information availability and updates. Rail yards can adopt similar initiatives to improve block, train and resource planning while automating processes to enhance operational reliability and improve efficiency. An experienced partner can help in intelligent rail yard planning, digitalizing inspection, and getting periodic rail layout review, enabling CXOs and yard staff to achieve performance goals through better safety, flexibility, increased visibility, and cost optimization.

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About the author

Rakesh Sahu

Senior Business Solutions Consultant, Railway Solutions, TCS. He has over 25 years of experience across the travel and transportation, and banking verticals. Rakesh's areas of interest include railroads, digital transformation, application migration, operations research and artificial intelligence.

Contact

Visit the Travel, Transportation & Hospitality page on https://www.tcs.com

Email: tth.marketing@tcs.com

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