Implementation of Fleet Management System at Noamundi Iron Mine, Tata Steel Ltd

Pankaj Kumar Satija[1], R.P. Mali[2], Sanjit Kumar Adhya[3], Rahul Kishore[4], Manish Kumar[5]

Abstract:

Noamundi Group dispatches around 12 Million Tons Per Annum(MTPA) of Iron ore to Jamshedpur and Kalinga Nagar Steel Plant of M/S Tata Steel Ltd. Noamundi group consists of two iron ore mines, Noamundi and Katamati, having a common processing and beneficiation plant, situated at Noamundi. Total material handling requirement to meet 12 MTPA finished product is 22 MTPA. The real challenge of Noamundi is to meet the product quality within a standard deviation of 0.2 (in the product alumina). To improve the material handling capability with respect to global benchmark vis a vis maintaining the product quality within stipulated standard deviation, the division took an innovative project to implement fleet management system. Total 41 numbers of Heavy Earth Moving Machineries (HEMMs were covered under the fleet management system. The main purpose of the project was to optimize the OEE (Overall equipment effectiveness) of HEMMs. Initially the project was executed with fixed dispatch mode (With fixed sources and destinations) with a way forward for dynamic dispatch mode in which assignments would be dynamic based on the real-time performance and requirement. In the present paper, the implementation journey of Fleet Management system with its features and advantages have been described.

Keywords: Fleet Management System; OEE (overall equipment effectiveness); Total Material Handling; Dynamic Dispatch

Fleet Management System: Concept

Fleet Management System is a modern version of real time tracking of HEMMs in highly mechanized opencast mines. High precision Global Positioning System devices are installed in each HEMMs so that geo tracking of each HEMM be obtained in real time condition. Following prerequisites are required for the tracking of HEMM in fleet management system

- Radio frequency signals (Through installation of fixed towers or movable rovers) in and around the geo-boundary of the concerned area
- Data transmission through OEM interfaces in each machine
- Installation of fuel sensor in each machine (For real time fuel consumption tracking)
- Import of dig blocks and slice plan for grade control
- Installation of fleet management system in each HEMM and necessary networking.
- Establishment of a control room with live displays
- Communication system between dispatcher (who sits at control room) and HEMM operator.
- Assigning boundaries of different destinations and creation of route map in line with haulage road assignments (To track movement in any undesired/unauthorized path)
- Creation of time usage model specific to mine condition (To track the availability, utilization, detentions etc in real time condition)
- Training to operators and dispatchers

Real advantage of fleet management system over earlier GPS based Truck Despatch System is the feature of dynamic dispatch facility which real time assignments to each operator is auto generated based on the objective of the user department. Dynamic dispatch method follows the three step methodology:

Step 1: The schedule is calculated

Step 2: The next 5 trucks requiring a dispatch are determined, including the truck that triggered the dispatch calculation

Step3: Up to Several thousand of possibilities are considered for trucks. If "N" trucks are assigned to "M" shovels then number of assignments = M_N

Advantages of fleet management system:

1. Improvement in OEE (Overall equipment effectiveness of equipment.

[1]General Manager, OMQ Tata Steel, [2]Chief Noamundi, [3]Head Operations, Noamundi, [4]Head Katamati, [5]Sr Manager Operations, Noamundi, 6Manager Operations, Katamati

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2. Grade control and blend production.
3. Tracking of real time performance of each equipment and operator.
4. Integration of OEM interface with FMS to get the real-time health status of each equipment.
5. Maximizing the production and productivity based on optimization of site constraints.
6. Reduction in operational Cost by 10 to 15%

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Operation Philosophy of Noamundi Iron ore Mine. In order to avoid re-handling and to meet requirement of only one customer ie Tata Steel own steel plants, mining is scheduled to have desired RoM feed from multiple locations to achieve product quality as mutually agreed in MoU with Steel plant. Scheduling is planned for life of mine study. Operation as per life of mine study helps in mineral conservation & lower standard deviation in product quality whereas optimum utilization of HEMMs with minimal idle time and dynamic allocation improves cost effectiveness. The current project aims to improve the OEE of HEMMs by 10% which will result in 3Million Tons additional material handling with same fleet size. It will result in capital expenditure avoidance of procuring the machines. More-over with improvement in the productivity of HEMMs, the project also aims to reduce the specific diesel consumption by 10% which will result in cost saving and reducing carbon footprint..

1. Project Start Up

The entire project activities were broken up in following sequential activities:

1. Finalization of pit and dump locations based on medium term excavation plan.
2. Identification of the key locations for installation of radio frequency towers (both fixed and rover type)
3. Integration and interface with HEMMs and subsequent installation of FMS unit in all HEMMs
4. Summarization of key performance indicators to prepare the time usage model.
5. Finalization of operational philosophy for fleet management system.
6. Selection and training of dispatchers and system administrators.
7. Training to all HEMM operators.
8. Finalization of different reports (outputs) from FMS.

2. Integration and Interface with HEMMs

To complete the installation of FMS system in each HEMMs following activities were being carried out:

1. Fuel Sensor Installation in each HEMM (To track real time fuel consumption)
2. GPS antenna and Wi-fi Radio installation
3. Panel PC power and OEM interface connection.
4. Panel PC installation.
5. Integration of PLM (Pay load Monitor), TPMS(Tyre Pressure monitoring system) and VHMS(Vehicle health monitoring system) in case of dumpers.

Fig1: Different Interfaces in FMS

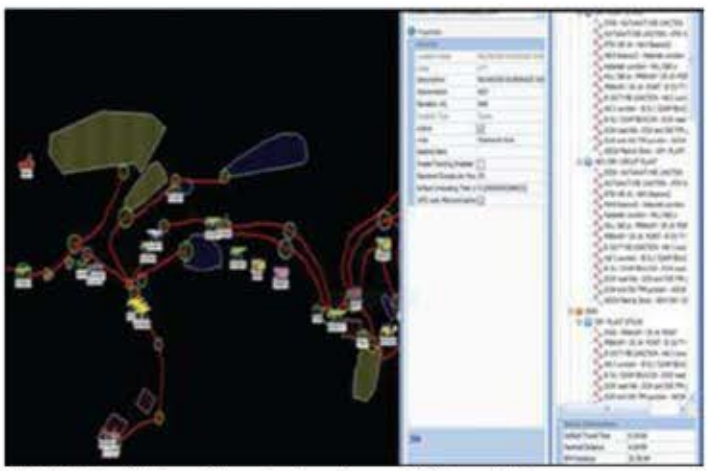


Fig2: Mine Vision Showing location of different dig

In the above figure (fig 1) the different interfaces of fleet management system have been shown. Wenco is the service provider for fleet management system in Noamundi. Mine vision is the interface in which real time HEMM tracking in the assigned path can be tracked. Wenco DB home is the system database. Even monitor is the interface in which different alarms with color codes are triggered. Fleet control is the interface which gives real-time information of the loading and hauling cycle of each HEMM.

3. Setting up dynamic dispatch requirements:

A. Set up of dig block and route map

The above figure (fig 2) shows the real-time position of each HEMM with respect to geo reference map/boundary

B. Design of Schedule Algorithm

Scheduling Requirements

- Short Term Operational Plan
- Projects production or blend and the required fleet size
- A "what if" analysis based on current constraints

Fig 3: Design of Schedule Algorithm

Fig 4: Decision Hierarchy chain

C. Setting of Decision Hierarchy (As explained in fig 4)

Operational Philosophy of FMS

1. Manning of FMS

For the manpower responsibility in the FMS, there is one Senior Manager from Tata steel, who is the overall project in-charge. Network specialist and hardware specialist have been provided by wenco, the service provider. Dispatcher roles be executed by the senior managers (Mining Engineers) in respective shifts

Overview of the Dispatcher Role

- Dispatchers are responsible for overseeing all events in the mine and ensuring that operations run smoothly. The Dispatcher is often required to make decisions that affect how well the mine is operating and even employee safety.
- Some of the functions of the Dispatcher role include monitoring and controlling mine events and equipment status/performance; creating dispatch groups; generating reports; providing information to mine personnel on policies and procedures; promoting safety and solving problems.

2. Badge in and Badge Out Status

Each Operator in the FMS system needs to maintain following minimum requirements regarding his login in the FMS system.

1. Badge in at shift start
2. Status Change (Before Tea Break)
3. Status Change (After Tea Break)
4. Status Change (Before Shift End)
5. Badge out at shift end

Table 1: Log in Status of Operators in FMS server

The table above (table 1) shows the equipment wise login status Dispatcher needs to ensure that the login is done as per the requirements.

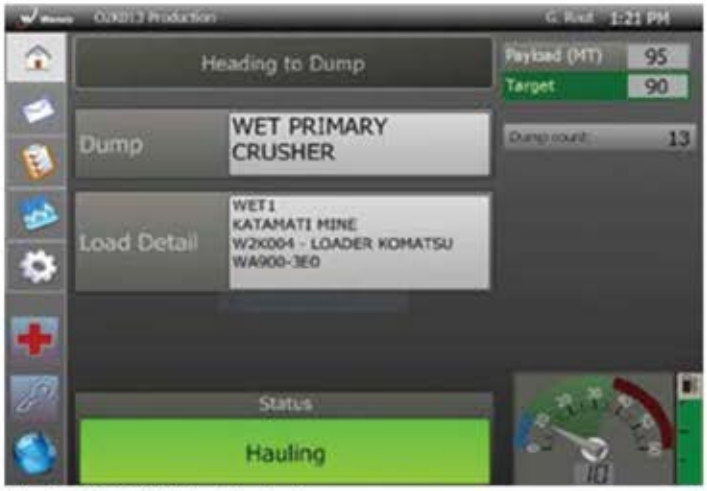


Fig 5: MDT (Mobile display)

3. Communication between dispatcher and operator.

There is a mobile display terminal in each HEMM, where there is an SMS option which can be used for manual or auto generated message. In case of any trouble shooting communication be made through walkie talkie.

The figure above(Fig5) shows the mobile display terminal installed in each machine. It basically is a smart computer, in which operator can do the following

- Receiving/sending messages to the control room
- Badge in/ Badge out/ status change
- Fuel level through online sensors
- Dump and load detail

4. Real Time Fleet Control in FMS

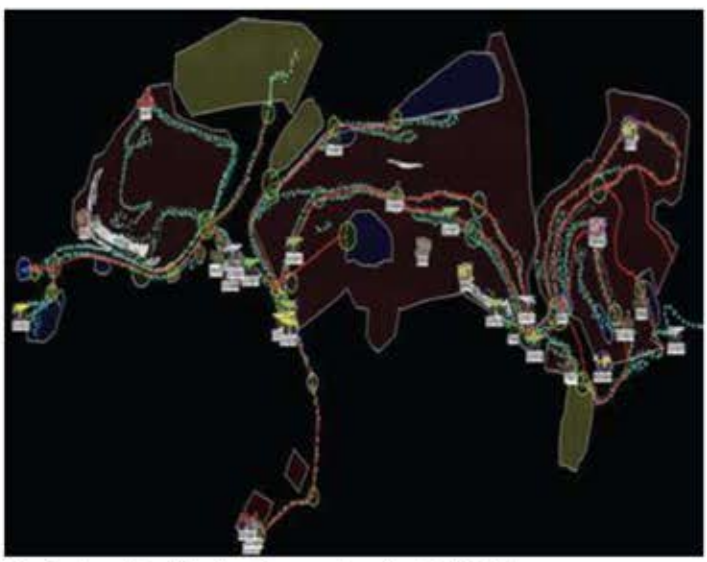


Fig 6: Tracking the location and route of HEMMs

Fig 7: Real Time Status(loading/hauling)

The dotted line in the above figure (fig 6) shows the designated /assigned pathways for respective dig location. The figure above (fig 7) shows the real time loading and hauling status of each HEMM. Different color codes are used for better tracking. For eg: Red color for breakdown, pink color for loading, green color for hauling, yellow color for idling/waiting

Fig 8: Different alarms triggered in even monitor in case of process deviation

The figure above (fig 8) shows the event monitor in which different event Ids are generated specific to a machine health/performance. Red color refers to an alarm which needs immediate attention. Yellow color is for warning and green color for informational message.

6. Reports generated through FMS

For the user specific requirements total 12 no of dashboards have been created to have a performance check. The figure below (fig 9) shows the different dashboards with the dashboard title (specific requirement)

Fig 9: Different Dashboards to See the performance

Chart1: Realtime Production Report

The chart above (chart 1) shows the production tracking dashboard in which real time production against each origin and equipment is tracked. Based on the current performance the production projection for the shift is calculated.

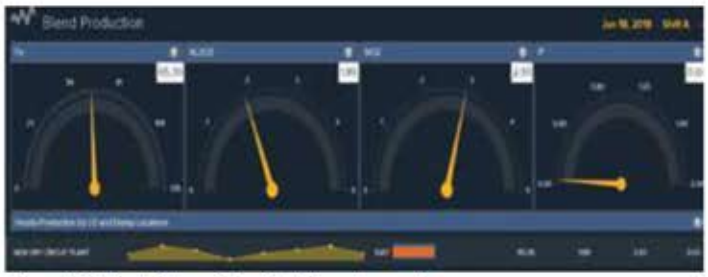
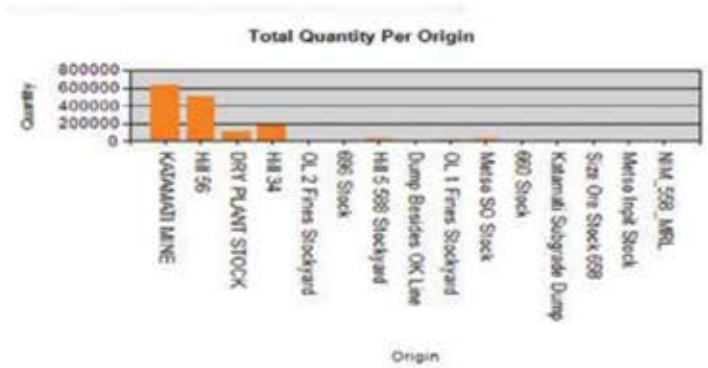


Chart 2: Real Time Quality Blend report

Chart 3: Equipment Status Summary



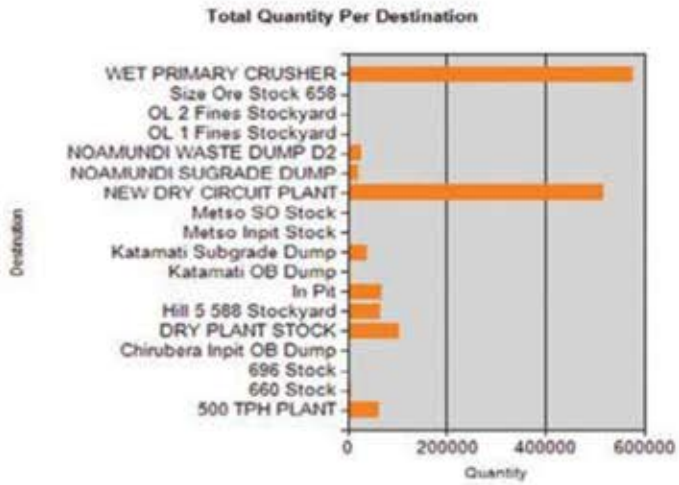


Chart 4: Material Break Up by Origin and Destination

The chart above (chart 2) shows the grade wise production from a particular dig block. Real time grade value is calculated based on the scheduled dig block. The chart above (Chart 3) shows the OEE analysis with respect to God hours(8 hours for 3 shift basis making 24 hours in a day) in a particular shift. Time usage model has been framed to capture each detention/break in a particular shift.

The above chart (Chart 4) shows the origin and destination wise material break up. It helps for proper excavation planning and compliance

7.Summary and Conclusion

Tata Steel Noamundi Mine has implemented the Fleet Management System as an innovative project under the digital initiative drive, to optimize the production and productivity with high precision in grade control vis a vis achieving the global benchmark in the OEE of HEMMs. In the initial phase, the mine has set a standard business rule for the operational control, all the operators, dispatchers and system administrators have been trained as per their module. Currently the operation has been stabilized with a pre-defined set of attributes to achieve the production and productivity. Way forward is to successfully implement the dynamic dispatch module in which real time auto assignments will be generated based on customer requirements and site constraints. This system is very user-friendly system and can be implemented in Indian Mining conditions with a ultimate objective of natural resource conservation and cost effectiveness.

Appendix A
(List of Abbreviations)

• GPS- Global Positional System; • FMS- Fleet Management System; • PLM- Pay load Monitor; • OB- Overburden; • OEE- Overall Equipment Effectiveness; • OEM- Original Equipment Manufacturer; • ROM- Run of Mine; • TPMS- Tyre Pressure Monitoring System; • VHMS- Vehicle health Monitoring System; • MTPA- Million Tons Per Annum; • HEMMs- Heavy Earth Moving Machineries.