Iron ore case analysis essay sample

Issues

* To minimize total waiting time and stockpile re-handling costs (Keep operations costs as low as possible). * To improve productivity process and decreasing idle time of machines and labor.

Background

* Iron Ore Company of Ontario is working in the business field of processing iron ore. * Production was scheduled on a year-round, 24 hour-per-day basis to produce over 46 million tonnes of crude ore per year, of which 21 million tonnes are high grade concentrate. * To achieve this capacity, a concentrator was built with input capacity of 1760 cubic meter of crude ore per hour, i. e. concentrator was used at full capacity at all times. * Production Process

* Large drills cutting 12-metre holes into solid rock. * These holes are then filled with explosives.

* Electric Shovels start to load the trucks.

* Trucks carry waste material to waste dump outside the mine, while ore was carried to the crushers. * The ore enters the crushers, where large rocks were reduced in size. * The crushed ore passed by conveyor to the concentrator where it was further crushed into waste tailings and 66% iron concentrate. * The concentrate product was finally loaded on a ship and exported to Europe and North America. * Shovels

* Shovels load an average of 480 cubic meters per hour per unit. * 7 Shovels were available per shift in Ore Zone, while the 8th Shovel was located at

crude-ore stockpile “ for less usage”. * Remaining Shovels were undergoing maintenance.

* Tractors

* Tractors clear loose rock from the loading area while shovel was waiting for trucks, so that loading area becomes smooth to reduce truck-tire wear. * Tractor works one hour for each hour worked by stockpile shovel, plus 1. 5 minutes per load dumped on the stockpile. * Trucks

* Trucks transfer the ore from the shovel in the mine to the crushers, then return to transfer the other load back to the crushers, and also transfer the waste to waste dumps. * 4 trucks were assigned to each shovel; and the truck assigned to shovel working in ore travels about 1. 5 kilometers between shovel loading area and the crushers. * The Crushers

* There were 2 crushers; together they were able to handle a maximum of 9420 tonnes per hour. * Two trucks could dump simultaneously into each crusher, with an average time of 1. 7 min (0. 028 hr) to dump. * There was considerable wear and tear of machinery in crushers due to weight and hardness of rocks. Thus, one crusher was almost closed during the day-shift, reducing the intake capacity of crushers from 9420 to 4710 tonnes per hour. * The 2 crushers remained working during afternoon and night shifts, but for the day shift, one crusher is working and the other is under maintenance. * The Stockpile

* Stockpile stage was created about 120 meters from the crushers, so that loaded ore trucks dump the ore in the stockpile rather than returning loaded to the mine when both crushers are down. * About 15 minutes of production

was lost each time a shovel changed location from ore zone to waste zone. * The cost of ore reaching the stockpile was the same as the cost of ore entering the crushers; as the time required for a loaded truck to come from shovel in mine, turn and dump on the stockpile was effectively the same as the time needed to carry ore to one of crushers, turn, and dump. * Any ore dumped on stockpile should ultimately be moved to the crushers, provided that trucks only haul 252 cubic meters per hour over short distance to the crushers.

Current Condition

* Average Mining capacities for both Shovels and Trucks

Capacity| Shovels| Trucks|

Cubic Meter / load / unit| 11. 5| 36|

Cubic Meter / hr / unit| 480| 128|

The main problem is the long time it takes to transfer the ore from shovels in the mine to the crushers and then returning back to the shovel for reload.

Each Shovel takes 11. 5 m3 / load with 480 m3 / hr to get 0. 024 hr/load.

Each Truck takes 36 m3 / load with 128 m3 / hr to get 0. 28 hr/load.

Load a truck 36 m3 / load with Shovel 480 m3 / hr to get 0. 075 hr/load.

Dump time by a truck in hr is given as 1. 7 min or 0. 028 hr. Calculations|

Shovels| Trucks|

Hr / load | 0. 024 | 0. 28 |

Load time for a truck / shovel by hr | 0. 075 |

Dump time for truck by hr | 0. 028 |

Trip time for truck without load and dump time by hr | 0. 177 |

The whole trip takes 0. 28 hrs or “ 16. 8 mins”.

Trip= time taken to load truck by shovel + time taken from shovel to crusher+ time taken for dumping+ time taken to drive back from crusher to shovel. So 0. 28 = 0. 075+ time taken between shovel and crusher (twice) + 0. 028 So time taken between shovel and crusher (twice) is 0. 177 hrs, so each trip takes 0. 0885hrs (5. 31 mins).

Exhibit 8 “ Distribution of crusher delays during day shift” From summary Statistics, we found that:

* Mean Delay = 12. 86 minutes = 0. 214 hrs

* Number of Delays = 332

* Sampling Interval = 120 days

* Given: 8 hours shutdown during day shift for a crusher

Thus, average down time (delay) per shift = (332 * 0. 214) / (120 * 8) = 0. 0740 hrs per shift or 4. 44 min per shift. | Truck 1| Truck 2| Truck 3| Truck 4| First load start| 0| 4. 5| 9| 13. 5|

Load time for each truck = 4. 5 min or 0. 075 hrs|

First load finish| 4. 5| 9| 13. 5| 1 818|

We used 4. 5 min for load time and zero starting point for facilitation, so each truck waits 4. 5 min (0. 075 hrs) for its predecessor to finish loading.

Root Cause Analysis

1. A concentrator was built with an input capacity of 1760 cubic meters of crude ore per hour. Why? Because it was the policy of the mine to operate the concentrator at capacity at all times. Why? To accommodate the yearly

schedule of 24 hours per day basis production of over 46 million tonnes of crude ore per year, of which 21 million tonnes are of high grade concentrate.

2. Tractors were assigned to operating shovels.
Why? Because the tractor cleared loose rocks from the loading area while shovel was waiting for trucks. Why? To smooth the loading area to reduce truck-tire wear.

3. There is a reduction in intake capacity of crushers from 9420 to 4710 tonnes per hour during the day shift. Why? Because of the daily 8 hours shutdown of one crusher for repairs and maintenance during the day shift. Why? Crushers are prone to bridging that occurs when a large rock jammed between the jaws of the jaw crusher, blocking the crusher completely; and once it is blocked, it will remain closed until the rock is removed or shaken loose. Why? Because of the weight and hardness of the rock, there was considerable wear and tear on the machinery in the crushers.

4. A stockpile of 120 meters from the crushers was created. Why? So that loaded ore trucks dump at the stockpile rather than returning loaded to the mine when both crushers are closed. Why? To reduce 15 minutes of production waste each time a shovel changed location to move from ore zone to waste zone.

5. Once a shovel-truck team began to produce, it was important that the team remain on the go. Why? Because long periods of waiting at crushers cause a considerable reduction in efficiency and productivity in the mine. Why? Workers in the mine conceivably feel frustrated and lose enthusiasm for their work, if their cycle were periodically disrupted.

Implementation Plan

* “ An internet Source”: informs that there is 1. 12 min idle time in shovel-truck cycle. * So Total cycle time = operating time + idle time = 0. 28 hrs + 0. 0186 hrs = 0. 2986= 0. 30 hrs = 18 mins. * Only one crusher works in day shift, i. e. for 8 hours, while 2 crushers work for afternoon and night shifts. So we have 3 working crushers with 5 shifts. * Given: Every day, about 128000 tonnes of ore are transferred to the crushers, and 2 crushers are capable of handling 9420 tonnes per hour. * So, both crushers need 13. 5 hours daily to achieve maximum production. * Since 128000 tonnes are moved daily, that means they pass through the 5 shifts, and that gives (128000 / 5) = 25, 600 tonnes / shift. * Because both crushers are working better at afternoon and night shifts, better allocate more shovels for these shifts than day shift. * Better communication channels between shovel- mine area crew and crushers area crew to stop sending loaded trucks when crushers aren’t working to save time and money.

* During drilling stage of production process, rock sizes should be smaller and softer to decrease wear and tear of machinery in crushers. * The stockpile is useful for ensuring a continuous flow of ore to the crushers during the 30 minutes each day that the mine was cleared for blasting, as well as during poor road conditions and shovel breakdowns. * So, stockpile is used when both crushers are closed or at least one is closed and we can’t have loaded trucks to transfer the ore to one crusher only, so the maximum intake capacity of crusher in case of stockpile is 4710 tonnes per hour. * Thus, 4710 tonnes per hour = 4710/60 = 78. 5 tonnes per min, and since

every 30 min there is flow of ore, then we can deduct that 78. 5 * 30 = 2355 tonnes are always flowed to the crusher from the stockpile.

* The distance between crushers and shovel is 1500 meters and time taken for that distance is 5. 31mins, so the new distance between stockpile and crusher is only 240 meters (back and forth) is only covered in = (240*5. 31) / 1500 = 0. 8496 min = 0. 01416 hrs. * The idle cost per truck is 26. 24$ per hour which equals 26. 24/60 = 0. 43733$ per min, while idle cost for shovels is 66. 56$ per hour which equals 66. 56/60 = 1. 10933$ per min. * We can reduce number of trucks to only 3 trucks to be used and thereby reducing one truck idle cost of 26. 24$/hr.

Benefits & Costs

Benefits

* Applying stockpile, if successful, will reduce the time and distance the ore will reach the crushers. (so ore will reach faster) * Decreasing waiting times at crushers and fixing machines maintenance will help increase efficiency and productivity with more workers' enthusiasm for their work, and thus decreasing idle time for both machines and labor. * Reducing one truck with its waiting time and saving 26. 24$ per truck/ hr. * Soften and decrease rocks size to decrease wear and tear of machinery in the crushers.

Costs

* Applying stockpile will incur additional costs of re-handling ore. * Longer waiting times at crushers cause reduction in efficiency and productivity in mine and that affects workers' morale and enthusiasm negatively. * Still, waiting trucks consume fuel about 10 percent of normal amount, in addition

to their maintenance and supplies expenses about 20 percent of the normal amount. While temporarily idle shovel consumed electricity at its normal rate and incurred maintenance and supplies expenses about 20 percent of normal rates. * Considerable wear and tear of machinery in one crusher results in one crusher closed during the day shift, reducing the intake capacity of crushers from 9420 to 4170 tonnes per hour. * Trucks often arrive from the mine with full load of ore only to find both crushers closed; so they return to the mine and dump the ore beside the shovel, which had changed location from ore zone to waste zone until crusher re-opened. Thus, 15 minutes of production was lost each time a shovel changed location to move from ore zone to waste zone.