Minxcon Group

# NEWSLETTER

**January 2019**

EXPLORATION | CONSULTING | PROJECTS

# Modes of Ore Transport

**Which mode of transport is most suitable for your operation?**


## NEWSLETTER SPOTLIGHT

◊ **Transport mode selection is mainly dependant on profitability.**

◊ **Practicality should also be considered as the most profitable mode cannot always be practically implemented.**

◊ **The switching point between trucking and conveying is a function of both the transport distance and tonnes transported.**

Selecting a mode of transport for ore both from underground to surface and on surface only is one of the most critical and problematic activities of mining engineering. The goal is the safe, most effective and ultimately most profitable method of transporting ore throughout various stages of the mining process. The selection of the mode of ore transport requirements may vary according to the lead distance, terrain, throughput requirements and geographical location, to name but a few factors. It is the intention of the analysis, however, to provide guidance on a very high level, in terms of selecting the most appropriate technology that would best satisfy these requirements in a cost effective and safe manner, while minimising any negative socio-economic impacts.

Typically, more than one mode of transport could be appropriate for a single operation, which may result in a combination of multiple feasible solutions for that operation.

Assume an example mining operation that has two feasible material transport solutions: the first being utilisation of loaders and trucks to transport ore from the mining area loading point to a RoM stockpile, and the second the utilisation of a series of conveyors. Both methods are feasible options, but which method is the most profitable?

Industry data will prove that if focussed on operating cost alone, typically the higher volume method will result in the lower unit cost per mined tonne. This could be used as a selection criterion, but an experienced engineer should consider all the other available data, specifically transport distances and also express the cost as a cost per tonne per kilometre.

Capital and operating cost of the various transport options as a function of distance to determine the best suited transport has been considered. Variations in monthly production has also be assessed in order to understand the impact that an expansion project would have on the transport mode costing. The input parameters that were used as a baseline from which the transport modes can be compared are listed in the table below.

*Analysis Baseline Input Parameters*

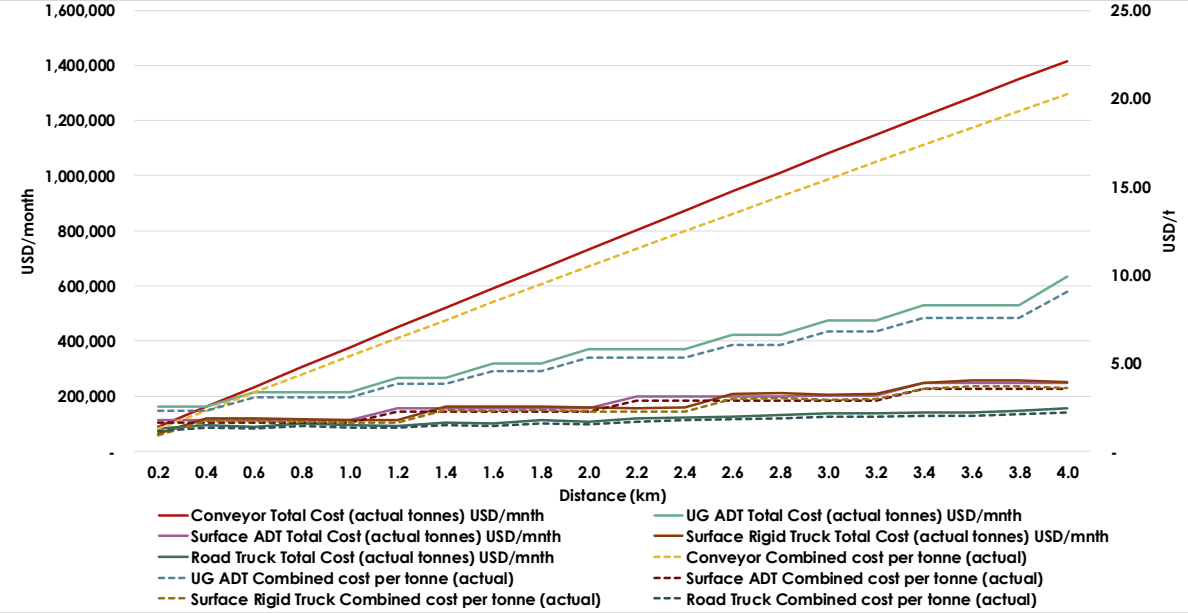
| Description | Unit | Value |
|---|---|---|
| Tonnes per annum | tpa | 840,000 |
| Tonnes per month | tpm | 70,000 |
| Days per month | days | 26 |
| Shifts per day | no. | 1 |
| Hours per shift | hrs | 9 |

| | | |
|---|---|---|
| Ore SG | t/m³ | 2.8 |

**Cost Comparison**

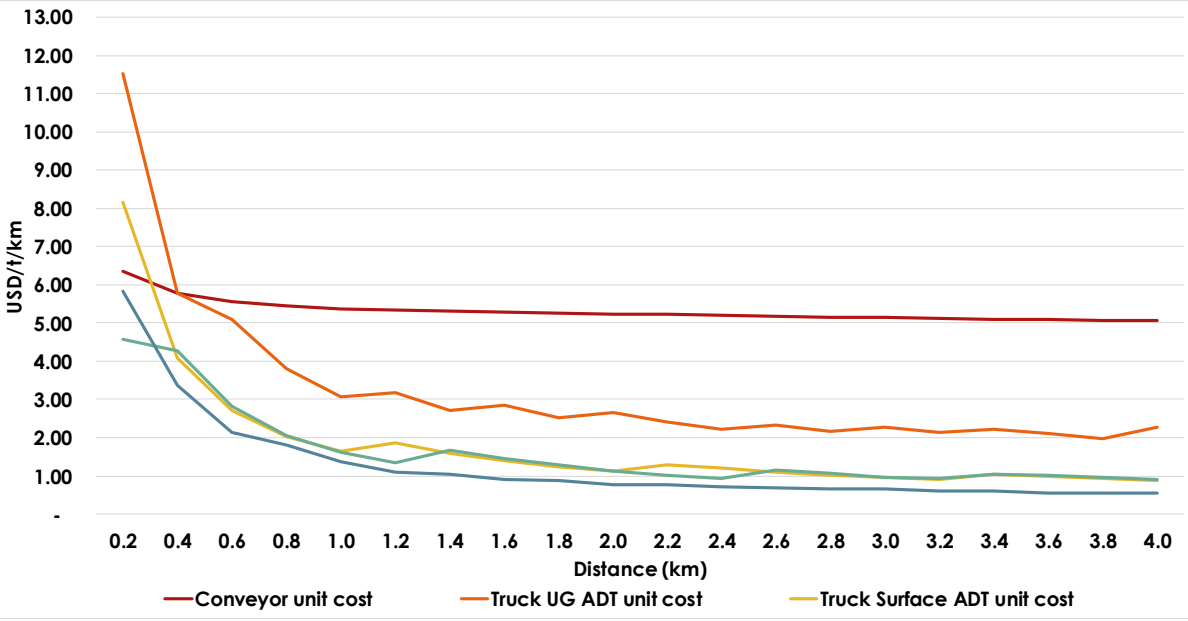
Transport via conveyor and the various trucking modes were compared over a range of distances starting from 0.1 km to 4 km and was consistently varied in 0.1 km increments. Operating cost for both the conveyor and trucking options was calculated as a function of distance in order to obtain representative values. Capital for both options were divided over a period of 36 months to capture a form of repayment and to combine this with the total monthly operating cost. The resultant monthly capital cost as well as unit cost per tonne for a 70 ktpm operation are illustrated in the chart to follow.

*Transport Mode Cost Comparison – USD/month & USD/t*




From the above comparison it is clear that for shorter distances a conveyor is the more viable option. For distances exceeding 400 m however, trucking poses a better solution. The steps evident in the costs associated with trucking is a function of the increase in the fleet size as a result of the increased haul distance. When expressing the results above as a unit cost per tonne per kilometre the resultant cost profiles are illustrated in the chart below.

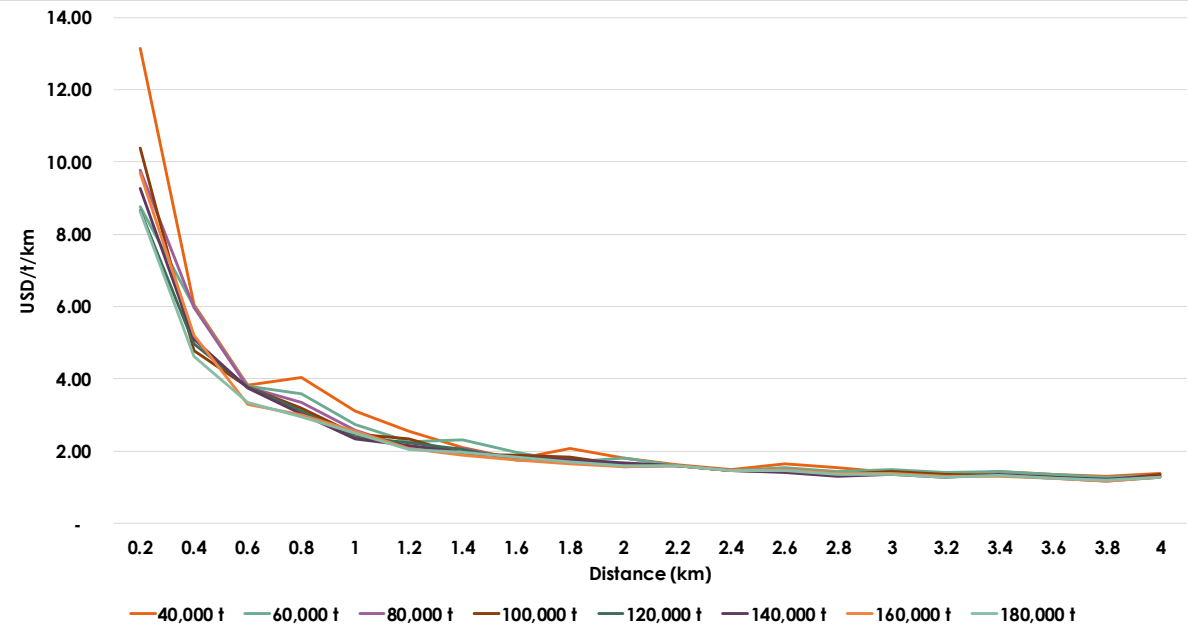
*Transport Mode Comparison Unit Cost - USD/t/km*



**Volume Sensitivity**

Operating costs, however, are also dependent on production rates, and higher monthly volumes often result in lower running costs. To assess this, monthly production was varied in constant 10 ktpm intervals from 30 ktpm to 180 ktpm. Results again are displayed over a range of distances. The results of this volume sensitivity for one of the trucking options (surface ADT) are illustrated in the chart to follow.

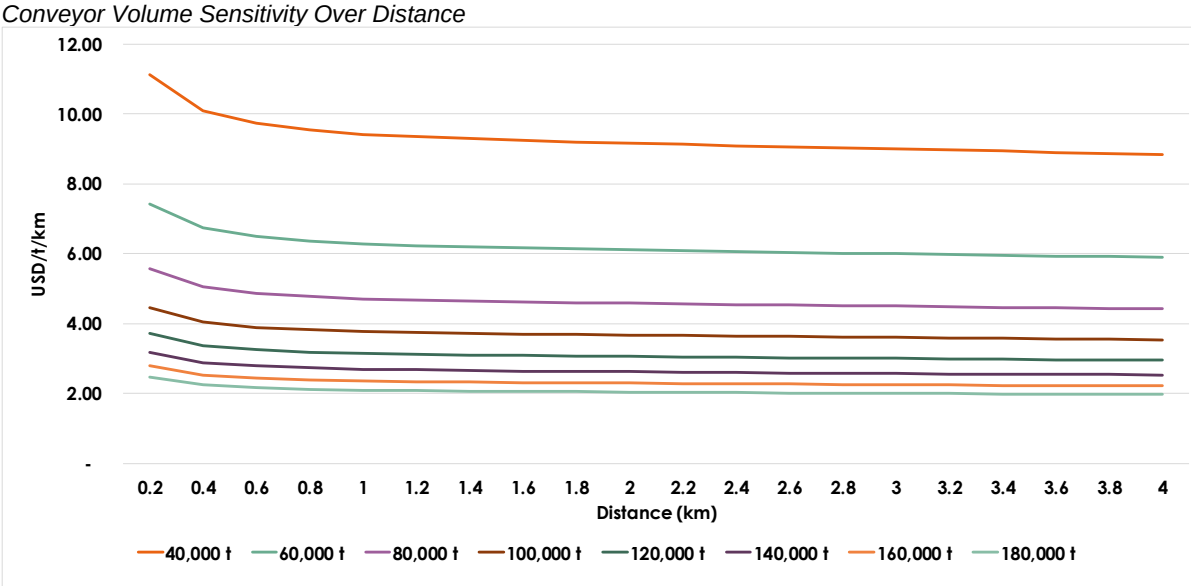
*Surface ADT Trucking Volume Sensitivity Over Distance*




The results for trucking show that this transport method is not sensitive to an increase in production and the average unit cost per tonne per kilometre stays relatively constant. Duplicating these results for the remaining trucking options yields similar results.

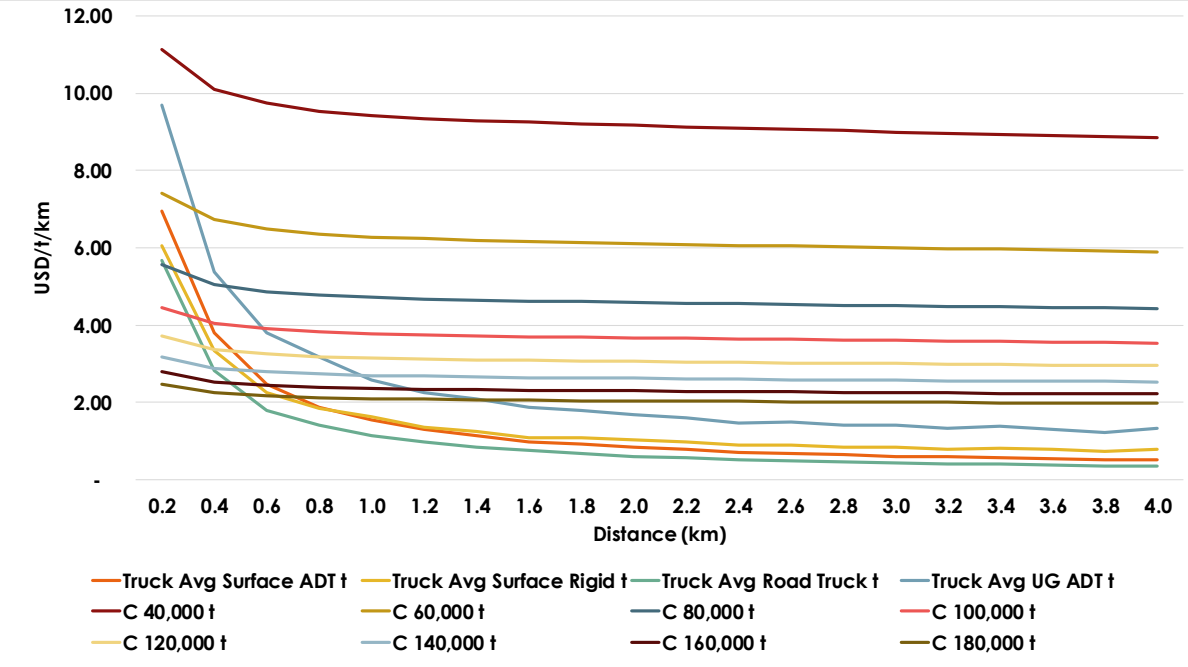
Considering the same sensitivity to a variance in production volumes yield the results indicated in the chart below.

*Conveyor Volume Sensitivity Over Distance*




The results for conveyors show that they are much more sensitive to a change in production volume compared to trucking. At larger production volumes, conveyors could subsequently be a better option than trucking. To test this an average unit cost was calculated for trucking as the costs stay relatively constant, and this was compared to the volume sensitivity of conveying. Results for the distances reviewed in this analysis are illustrated in the chart to follow.

*Average Per Trucking Mode vs. Conveyor Sensitivity Comparison*




For larger production volumes, conveyors are thus a better option than trucking, again depending on the transport distance. Ultimately though, for transport distances in excess of 1.4 km, trucking proves to be a more cost-effective option than conveying.

## Practicality

Apart from the various cost factors considered as part of the analysis, practicality of the various transport modes also needs to be taken into account. One may find that the most cost-effective mode may not be practical to implement for a specific operation or environment. A few of the practical considerations for conveyors and trucking are listed below.

Conveyors:

- **Safety**. The conveyor in its entirety is considered a moving machine and thus poses a safety risk to locals, and may cause serious injury or even a fatality.
- **Security**. Security with conveyors is a definite concern. Not only could product be stolen from the conveyor, the conveyor itself could fall victim to vandals, and fencing as well as conveyor components could be stolen during off-shift times. As the lengths of a conveyor increase it becomes increasingly difficult and costly to secure.
- **Downtime**. Should one conveyor in a series of conveyors fail, it would be a timeous task to clean spillage, pull in and repair the conveyor while the total system will have to be halted. This can amount to extensive downtime during which no material can be transported.
- **Conveyor installation**. As conveyors are preferred to run in straight lines the area will have to be cut and filled due to the changes in local topography in order to facilitate a conveyor belt. For short single flight conveyors, they rarely exceed angles of 15° although angles of up to 17° are known to be used. This is highly dependent on the characteristics of the material being transported. For overland coal conveyors, however, findings by Sasol (Synfuel company, South Africa) have shown that a maximum of 12° (rise or fall) should be maintained. This flatter angle will result in unnecessary cut and fill costs.

Trucks:

- **Safety**. Safety on haul roads is only relevant in the immediate vicinity of the truck, thus minimising the exposure to risk. This risk can be further reduced by thorough operator training and speed limitations.
- **Flexibility**. Should a truck break down, production will not be hampered as other trucks in the fleet can continue to transport material. Availability of trucks can be increased even more by providing for a spare standby unit.
- **Security**. Trucks can be parked at a dedicated parking lot during the out-of-shift times which makes it easier to secure and protect the fleet.

- **Labour**. Trucking is a labour-intensive transport method and is thus vulnerable to strikes by the local workforce.

## Conclusion

The operating cost for trucking over short distances, in general, is higher than that of conveyors. Longer overland conveyors on the other hand become more expensive as a larger capital investment needs to be maintained on a regular basis.

From the results obtained, trucking is considered a cheaper option than conveying after a distance of approximately 400 m.

When considering volume sensitivity, it was found that trucking operating costs stay fairly constant while conveying proves to have a definite decrease in costs as production increases.

Minxcon has set up an effective model to run various scenarios, and is ultimately able assist in selecting the most optimal mode of transport.

**For more information please contact**
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Minxcon Exploration

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