The ROI of Readi FMIS

Discover how 2 mines each achieved a $6M annual benefit in productivity and safety improvements using Readi FMIS.
Table of Contents

Introduction .................................................................................................................. 3

Background

Predictive vs. Reactive Fatigue Tech ........................................................................ 4
Overview of Readi FMIS ............................................................................................ 5
Scientific Background .................................................................................................. 6

Methods of Achieving Benefits with Readi FMIS ......................................................... 7

Summary of Benefits

from Fatigue Reductions ............................................................................................... 8
from Task Assignment Optimization ............................................................................... 9

Adding It All Together: ROI ........................................................................................... 10

Conclusion & Next Steps ............................................................................................... 12

Appendix

Methodology of Fatigue Reduction Benefits ................................................................. 14
Methodology of Task Assignment Optimization Benefits ............................................ 18
Reference Customers ...................................................................................................... 20
Introduction

Readi FMIS, the Fatigue Management Information System from Fatigue Science, is rapidly growing in use by major mining firms worldwide. In this whitepaper, we explore how two North American mines are each achieving a projected $6M financial benefit from their use of Readi to manage fatigue.

These gains include projected increases in productivity as well as safety cost reductions.

With substantial results like these, it’s no surprise that worker fatigue optimization is emerging as a C-level strategic priority for the world’s leading firms in mining and heavy industry.

Fatigue’s Impact on Heavy Industry

Throughout mining and other heavy industry sectors, worker fatigue is recognized as a costly and deadly problem – affecting both employers and employees alike.

Most commonly, worker fatigue is associated with major accidents and fatalities, and the notion of an operator “falling asleep at the controls” is an ever-present concern in 24/7 operations.

But while catastrophic losses are certainly the most recognizable effect of fatigue, data increasingly reveals that fatigue’s impact on operations is far more pervasive. It’s now possible to quantify fatigue’s impacts not only on safety, but also on productivity.

Predictive fatigue data, like those provided by Readi FMIS, is the key to calculating fatigue’s full impacts. And fortunately, Readi FMIS enables employers not only to measure fatigue’s impact, but also to prevent some of those losses and make significant gains in operational productivity.

In this whitepaper, we explore large data sets from two leading mine sites who have been using Readi FMIS in daily operations for over a year. From these data, we quantify the benefits to productivity and safety attributable to the use of Readi. Ultimately, we calculate an ROI for a representative mine site and present next steps on how your mine or industrial operation can achieve the same.
What is Predictive Fatigue Management?

Fatigue management is a broad term encompassing both technological and non-technological methods to manage the impacts of operator fatigue. Best practices recommend a “layered approach” to fatigue management, where multiple strategies are deployed together for maximal impact. In this context, “predictive” fatigue management opens up powerful new avenues to achieve benefits beyond what is possible with the use “reactive” technology alone.

**Reactive Tech**

Reactive fatigue technologies emerged in the early 2000s. Typically, they involve in-cab cameras that attempt to detect an operator falling asleep shortly before an accident is imminent (a “micro-sleep”). By raising alarms in these critical moments, reactive technologies act as a “last resort” and are intentionally disruptive to operations. Stopping a vehicle and shaking a driver’s seat, for instance, involves temporarily pausing short-term productivity in an attempt to avert catastrophe.

- Cameras
- PVT Tests
- Seat Vibrators
- Glasses
- Hats

**Predictive Tech**

By contrast, predictive fatigue technologies act as a “first resort” – improving safety and productivity, hand-in-hand. Predictive technologies generate data long before critical fatigue events are imminent. These data enable proactive decisions at different times and by different roles within an organization – including by supervisors, dispatchers, management teams, and operators themselves.

![Graph showing fatigue levels over time]

Now: 92
10:35pm: 80
14:00am: 70
Readi FMIS is the world's leading predictive fatigue technology, designed specifically for mining and heavy industry. As a Fatigue Management Information System (FMIS), Readi not only generates validated predictive fatigue data, but also makes these data available to the relevant parties at the right moments to enable proactive decision-making.

Most prominently, supervisors and dispatchers receive Readi's predictive fatigue data at the start of each shift. With these data, they optimize daily task assignments for operators under their purview. Supervisors may re-allocate the most challenging tasks to less fatigued operators, and they ensure that the most complex tasks are performed by the right worker at the right time of day. In rare cases, a supervisor may ask a critically fatigued operator to rest (non-punitively) if no suitable low-risk tasks can be substituted.

Separately, individual operators have a role to play in using predictive fatigue data to reduce risk. Each day, operators receive sleep data and personalized fatigue predictions for their shift ahead. Data are displayed on their wrists, via ReadiWatch, Fitbit, or Garmin device, and optionally on their smartphone. Through daily exposure to personal sleep and fatigue patterns, operators have been shown to gradually improve their sleep habits, which in turn reduces aggregate fatigue levels for an organization.
Scientific Background:
How does Readi predict fatigue?

Readi generates daily, personalized fatigue predictions for participating operators by analyzing their trailing 10 days of sleep data in combination with circadian factors.

Analysis is performed automatically via a validated biomathematical model known as SAFTE™. SAFTE was developed by researchers at the US Army’s Walter Reed Army Institute of Research and has been validated independently by the US Department of Transportation, US Federal Aviation Administration, and in 13 published independent papers. The model is exclusively available from Readi FMIS and is widely considered the world’s leading fatigue model.

SAFTE analyzes a wide array of factors to predict fatigue, including cumulative historical sleep duration, quality, and timing, as well as circadian factors like sunrise/sunset times, night shifts, and time zone travel. These factors are considered not just for the prior 24 hours, but for the past 10 days, as indicated by the science.

Sleep data is either captured from validated wearable devices (e.g. ReadiWatch, Fitbit, or Garmin) or it can be estimated as needed. Such estimations are made by Readi’s Machine Learning engine, which analyzes an operator’s personal work hours from the past 10 days, combined with any past sleep history the operator may have recorded and any demographic data. Readi then compares the available data to an anonymized database of millions of industrial sleeps labelled with similar data in order to predict the operator’s trailing 10 days of sleep, or to fill any gaps in the operator’s sleep history. With 10 days of real or estimated sleep, SAFTE generates a daily, personalized fatigue prediction for the operator, for each of the 18 hours subsequent to an operator’s wake. These fatigue predictions are known as the “ReadiScores.”

The ReadiScore quantifies fatigue on a scale of 1 to 100, predicting cognitive effectiveness, reaction time and lapse likelihood. A lapse is a measure of attention deficit closely related to the tendency for a microsleep, or “nodding off at the controls”. At a ReadiScore of 70, the impact on those 3 factors is roughly equivalent to that of having a Blood Alcohol Concentration of 0.08.

Additionally, the ReadiScore has been observed to have a direct relationship to real-world operator performance in mining environments and other areas of heavy industry. Key productivity metrics, such as Dig Rate and Spot Time, and safety data, such as video-captured microsleeps, were correlated with operators’ ReadiScores. These metrics are used in calculating ROI in this whitepaper.

For more information on the SAFTE Model or how Readi works, visit [www.fatiguescience.com](http://www.fatiguescience.com).
Quantifying the Benefits of Readi FMIS

This whitepaper will focus on quantifying the financial and safety benefits of each of the two primary methods by which Readi FMIS generates value, namely:

1. Fatigue Reduction

Aggregate reduction in on-duty fatigue levels across the operation as operators, supervisors, and management benefit from Readi FMIS’s daily fatigue insights.

2. Task Assignment Optimization

Supervisors using Readi FMIS to make daily decisions at the start of shift to assign tasks to workers in consideration of personalized fatigue predictions.
Calculating the Benefits: Fatigue Reduction

We begin our ROI Calculation by calculating the benefits of Fatigue Reduction brought about by customers’ use of Readi FMIS.

This calculation involves **4 major steps:**

1. Determine an operation’s Fatigue Risk Profile in baseline and subsequent periods
2. Link productivity metrics to the Fatigue Risk Profiles
3. Link safety metrics to the Fatigue Risk Profiles
4. Calculate the projected change in productivity and safety vs. the baseline scenario

The results of this analysis are summarized below.

**Scenario 1** represents the typical annual output and Fatigue Related Lost-Time Incidents (FR-LTIs) for a mine in our analysis under baseline conditions, **without Readi FMIS.**

**Scenario 2** represents the same metrics, but for the period of months 9 to 12, **after ongoing use of Readi FMIS for Fatigue Reduction.**

In Scenario 2, the mine’s Fatigue Risk Profile **has improved as a result of using Readi FMIS.** Fewer hours were worked in the “high” and “severe” fatigue ReadiScore Zones (0 - 70).

Metrics used for **per-hour** output and FR-LTIs **remain constant within each ReadiScore Zone,** with the change in overall results being driven by the change in Fatigue Risk Profile.

Comparing the scenarios, we project the following **benefits attributable to Fatigue Reduction** from Readi FMIS, per site annually:
- **Increase of $3.26M** in output
- **Decrease of 0.23 LTIs**
- **Decrease of $210K** in LTI costs

For a full discussion of the methodology used here, including the definition of terms and the basis for inputs, go to the **Appendix (page 14).**
Calculating the Benefits: Task Assignment Optimization

Having calculated the benefits of Readi’s Fatigue Reduction, we now calculate the additional benefits provided by Readi’s Task Assignment Optimization.

This calculation involves 2 major steps:

1. Determine how the operation’s Fatigue Risk Profile changes on account of Task Assignment Optimization
2. Calculate the projected change in productivity and safety vs. the previous scenario

The results of this analysis are summarized below.

Scenario 3 represents the impact of Task Assignment Optimization, in addition to the benefits of Fatigue Reduction from Scenario 2.

In Scenario 3, the Fatigue Risk Profile of safety-sensitive work hours has been further improved, as a result of using Readi FMIS. Less time is spent in the “high” and “severe” fatigue ReadiScore Zones, as fatigued operators are re-assigned to non-safety-sensitive tasks.

As with the previous analysis, per-hour output and FR-LTIs remain constant within each ReadiScore Zone, with the change in overall results being driven by the change in Fatigue Risk Profile.

Compared to the previous scenario, we project the following benefits attributable to Task Assignment Optimization from Readi FMIS, per site annually:

- Increase of $2.27M in output
- Decrease of 0.19 LTIs
- Decrease of $168K in LTI costs

For a full discussion of the methodology used here, go to the Appendix (page 18).
Adding It All Together
Determining Return on Investment

As we conclude our analysis, we summarize the projected benefits of Readi FMIS, comprised of improvements from “Fatigue Reduction” and from “Task Assignment Optimization”.

Total benefits are projected at $5.91M per site annually, comprised primarily of productivity gains, as well as a reduction in LTIs. On average, Fatigue-Related LTIs are projected to decrease by 26%, and consequently total LTIs are projected to decrease by 13%. A breakout of total benefits follows:

Baseline (Scenario 1)  Fatigue Reduction Benefit (Scenario 2)  Task Assignment Optimization Benefit (Scenario 3)

<table>
<thead>
<tr>
<th></th>
<th>Productivity Improvement</th>
<th>LTI Cost Reduction</th>
<th>Total Financial Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 (Baseline)</td>
<td>$3,255,201</td>
<td>$210,432</td>
<td>$3,465,633</td>
</tr>
<tr>
<td>Scenario 2 (F. Reduction)</td>
<td>$2,273,777</td>
<td>$168,448</td>
<td>$2,442,225</td>
</tr>
<tr>
<td>Scenario 3 (F. Reduction + Task Opt.)</td>
<td>$5,528,978</td>
<td>$378,880</td>
<td>$5,907,858</td>
</tr>
</tbody>
</table>

Fatigue-Related LTIs / Yr.  Total LTIs / Yr.

<table>
<thead>
<tr>
<th></th>
<th>Fatigue-Related LTIs / Yr.</th>
<th>Total LTIs / Yr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1 (Baseline)</td>
<td>1.60</td>
<td>3.20</td>
</tr>
<tr>
<td>Scenario 2 (F. Reduction)</td>
<td>1.37</td>
<td>2.97</td>
</tr>
<tr>
<td>Scenario 3 (F. Reduction + Task Opt.)</td>
<td>1.18</td>
<td>2.78</td>
</tr>
<tr>
<td>Total Improvement</td>
<td>-26%</td>
<td>-13%</td>
</tr>
</tbody>
</table>

For a full discussion of the methodology of these calculations, go to the Appendix (page 13).
The last step is computing **Return on Investment**.

To calculate the return on investment, we subtract the investment amount from the financial benefit, and divide by the investment amount. Readi FMIS technology is available on a subscription basis, with costs varying by the complexity of each site’s operation. We’ll use an average assumption of $288K USD per year for the representative sites in this analysis.

\[
\text{ROI} = \frac{\text{Benefit} - \text{Investment}}{\text{Investment}} = \frac{\$5.91M - \$0.288M}{\$0.288M} = 19.51
\]

Based on these projections, we project a **20x annual ROI** from the use of Readi, with an implied “payback period” of **under 3 weeks** on an annualized basis.
Conclusion & Next Steps

Eager to know what financial benefit Readi FMIS can have on your own operation?

Our dedicated Professional Services team at Fatigue Science supports each client’s Readi program through all aspects of deployment and ongoing operations, to ensure you’re getting the most out of your investment and achieving ROI to its maximum potential.

Our business analysts will also generate a customized Return on Investment analysis to quantify these benefits for you, at no extra charge.

Ultimately, predictive fatigue technology is one of the few areas where worker well-being and safety truly coincide with increases in operational productivity.

It is a rare “win-win” for employees and employers alike. It’s why mine sites and industrial operations on 96 countries are using Readi to improve operations – with adoption growing rapidly.

Reach out to our sales team to get started improving operational productivity and safety, and become a part of the predictive data revolution today.

Sales Inquiries:

sales@fatiguescience.com

+1 (604) 408-0085 - Canada
+52 (5) 568278152 - Mexico / Latin America
(Se habla español)

www.fatiguescience.com
Appendix

Methodology: Calculating the Benefits

of Fatigue Reduction ........................................................................................................ 14
of Task Assignment Optimization ................................................................................... 18

Reference Customers ....................................................................................................... 20
Calculating the Benefits: Fatigue Reduction

We begin our ROI Calculation by calculating the benefits of Fatigue Reductions brought about by customers' use of Readi FMIS.

This calculation involves 4 major steps:

1. Determine an operation's Fatigue Risk Profile in baseline and subsequent periods
2. Link productivity metrics to Fatigue Risk Profile
3. Link safety metrics to Fatigue Risk Profile
4. Calculate the projected change in productivity and safety vs. the baseline scenario

**Step 1**

The first step is to construct Fatigue Risk Profiles for the operation's workforce. We will construct a profile for a “Baseline” period, as well as one for a subsequent period 9 months later.

**What is a Fatigue Risk Profile?** A Fatigue Risk Profile (FRP) segments an operation's total work hours over a given period by the fatigue level of operators. In other words, an FRP answers “What percent of time are workers spending at high fatigue, moderate fatigue, low fatigue, etc.?”

To generate an FRP, we pool together all the ReadiScores that Readi FMIS has generated for operators in the analysis period, for each hour that they were on duty.

**To the right:** a sample set of FRPs, representing months 1 – 3 (“Scenario 1”) and 9 – 12 (“Scenario 2”) of a customer's use of Readi. These FRPs are similar to the actual FRPs achieved by the two mines in this analysis.

(Actual FRPs are not shared for privacy reasons.)

The “Scenario 2” FRP reflects the impact of fatigue reductions from implementing Readi FMIS.

The impact of these improvements is noticeable in the lower amount of time spent in the “High” and “Severe” fatigue categories, and the higher amount of time spent in “Low” and “Moderate” fatigue categories.

<table>
<thead>
<tr>
<th>Fatigue Level</th>
<th>ReadiScore Zone</th>
<th>Scenario 1 (Baseline)</th>
<th>Scenario 2 (Improved)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>90 – 100</td>
<td>11%</td>
<td>21%</td>
</tr>
<tr>
<td>Moderate</td>
<td>80 – 90</td>
<td>29%</td>
<td>32%</td>
</tr>
<tr>
<td>Elevated</td>
<td>70 – 80</td>
<td>29%</td>
<td>23%</td>
</tr>
<tr>
<td>High</td>
<td>60 – 70</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Severe</td>
<td>0 – 60</td>
<td>16%</td>
<td>11%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Our case studies indicate that customers using Readi FMIS achieve an average 21% reduction in “High” and “Severe” fatigue levels, compared to the baseline period.
Across broader operational metrics, The Journal of Occupational and Environmental Medicine estimated a 4% productivity loss attributable to operating while fatigued.\(^1\)

Combining these 3 separate metrics, we conservatively assume a 3.25% difference in operator efficiency when operating at Low Fatigue vs. High Fatigue across a general range of safety-sensitive tasks.

We can then translate these relative differences into a specific productivity-per-work-hour metric for each ReadiScore range. The numbers below are rounded for privacy, but are illustrative of the two mines in this study.

Our table assumes a mine with ~$1B USD in annual revenue, 1,000 operators, and 90% of hours & revenue attributable to safety-sensitive tasks.

\(^4\) "The Cost of Poor Sleep: Workplace Productivity Loss and Associated Costs", Journal of Occupational and Environmental Medicine, Jan 2010

Note: we assume the remaining 10% of tasks are Non-Safety-Sensitive, low-complexity tasks, for which output does not vary as meaningfully by fatigue level.
Now, let’s link safety metrics to fatigue metrics.

Similar to our approach in Step 2, we can use telematics data from mine sites to determine the relative risk of a Lost-Time Incident (LTI) for an hour worked in a given ReadiScore range.

Here we use video-verified microsleep data as a proxy for the risk of critical events at a given fatigue level. These data were provided by a Hexagon OAS camera system installed in participating haul trucks. The data revealed a 14x higher incidence of critical microsleeps in hours when an operator's ReadiScore indicated High Fatigue vs. Low Fatigue.

We can then translate this relative difference into a specific estimate of Fatigue-Related-LTI's-per-hour for time spent in each ReadiScore range.

We begin with industry data on total incidence of LTI’s-per-hour. In 2021, major mines experienced 0.32 LTIs per 200,000 hours worked.²

How many of these total LTIs were attributable to fatigue? A study by Caterpillar Global Mining found that 65% of all haul truck accidents were related to fatigue.³ To be conservative, we will only assume 50% of LTIs are fatigue-related.

With these assumptions, the table below illustrates that a typical mine in a baseline scenario can expect an average of 1.60 Fatigue Related LTI’s (FR-LTI’s) per year.

<table>
<thead>
<tr>
<th>LTI / 200,000 Hours</th>
<th>Work Hrs / Yr.</th>
<th>Safety-Sens. Work Hrs / Yr.</th>
<th>LTI / Year</th>
<th>% of LTIs Fatigue-Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.32</td>
<td>2,000,000</td>
<td>1,800,000</td>
<td>3.20</td>
<td>50%</td>
</tr>
</tbody>
</table>

Fatigue-Related LTI / Year 1.60

Finally, we combine the 1.60 FR-LTI figure above with the relative risk per hour in each ReadiScore range. We arrive at an average FR-LTI's-per-hour worked in each ReadiScore range, as shown in the table below.

(Note: We assume that “Safety-Sensitive” tasks are, by definition, the ones with a risk of LTIs. Therefore, the figures in the green column indicate the FR-LTI rate per 200K “Safety-Sensitive” work hours).

²Survey of sustainability reports for top mining firms, 2021
³Caterpillar Global Mining, 2007
Step 4

With metrics linking both productivity and safety to operator fatigue levels, we can now calculate the projected benefits of the observed reduction in an operation’s fatigue levels.

To do this, we multiply the number of Safety-Sensitive work hours in each ReadiScore range by the corresponding “per-hour” metrics for productivity and LTI’s.

Below are results for Scenario 1 (Baseline).

<table>
<thead>
<tr>
<th>ReadiScore Zone</th>
<th>Hours Worked</th>
<th>Implied Output ($M)</th>
<th>Implied FR-LTI’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 100</td>
<td>198,000</td>
<td>$101.14</td>
<td>0.02</td>
</tr>
<tr>
<td>80 - 90</td>
<td>522,000</td>
<td>$263.41</td>
<td>0.28</td>
</tr>
<tr>
<td>70 - 80</td>
<td>522,000</td>
<td>$260.83</td>
<td>0.39</td>
</tr>
<tr>
<td>60 - 70</td>
<td>270,000</td>
<td>$133.57</td>
<td>0.41</td>
</tr>
<tr>
<td>0 - 60</td>
<td>288,000</td>
<td>$141.05</td>
<td>0.50</td>
</tr>
<tr>
<td>Overall</td>
<td>1,800,000</td>
<td>$900.00</td>
<td>1.60</td>
</tr>
</tbody>
</table>

And below are results for the Scenario 2.

<table>
<thead>
<tr>
<th>ReadiScore Zone</th>
<th>Hours Worked</th>
<th>Implied Output ($M)</th>
<th>Implied FR-LTI’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 100</td>
<td>369,000</td>
<td>$188.48</td>
<td>0.04</td>
</tr>
<tr>
<td>80 - 90</td>
<td>583,200</td>
<td>$294.29</td>
<td>0.31</td>
</tr>
<tr>
<td>70 - 80</td>
<td>409,320</td>
<td>$264.52</td>
<td>0.31</td>
</tr>
<tr>
<td>60 - 70</td>
<td>243,000</td>
<td>$120.22</td>
<td>0.37</td>
</tr>
<tr>
<td>0 - 60</td>
<td>195,480</td>
<td>$95.74</td>
<td>0.34</td>
</tr>
<tr>
<td>Overall</td>
<td>1,800,000</td>
<td>$903.26</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Improvement vs. Scenario 1: $3.26 (0.23)

Comparing the scenarios, we project the following benefits attributable to Readi’s Fatigue Reductions, per site annually:

- **Increase of $3.26M** in output
- **Decrease of 0.23 LTI’s**

Lastly, we estimate the financial benefit of this decrease in LTI’s, based on the average cost of a Fatigue-Related LTI in the mining industry. Costs will vary by operation, but it’s important to consider both direct costs and indirect costs.

**Direct costs:** workers compensation payouts, medical costs, and equipment damage

**Indirect costs:** factors such as work stoppage, re-training, HR replacement, crisis management time, legal fees, reputational damage, and general resource use

We estimate the full cost of a Fatigue-Related LTI in mining to be $900,000 USD.⁴

<table>
<thead>
<tr>
<th>Average Cost of LTI in Mining</th>
<th>Any Cause</th>
<th>Fatigue Related</th>
<th>Non-Fatigue Related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>$100,000</td>
<td>$150,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Indirect</td>
<td>$500,000</td>
<td>$750,000</td>
<td>$250,000</td>
</tr>
<tr>
<td>Total</td>
<td>$600,000</td>
<td>$900,000</td>
<td>$300,000</td>
</tr>
</tbody>
</table>

Using this figure, we can quantify a **$210K avg. annual LTI cost reduction** attributable to Readi FMIS’s Fatigue Reduction at the mine site.

Comparing the scenarios:

- **Scenario 1 (Baseline):** FR-LTI = 1.60, FR-LTI Cost = $1,440,000
- **Scenario 2:** FR-LTI = 1.37, FR-LTI Cost = $1,229,568
- **Difference:** (0.23) $210,432

**Improvement:** -15%

---

⁴Fatigue-Related LTI cost estimation: The average direct cost for an any-cause LTI in the industry mining is approximately $100,000 USD.⁴ There is a typical ratio of 5:1 for indirect to direct costs, i.e. $600,000 in total costs for an any-cause mining LTI.⁵ Research from the US Dept. of Transportation indicates that Fatigue-Related accidents tend to be among the most severe accident types. Specifically, Fatigue-Related accidents were found to be 5x more costly than non-Fatigue-Related accidents.⁶ To be conservative, we estimate Fatigue-Related LTIs (FR-LTI) are only 3x more costly, not 5x. Consequently, we estimate the full cost of a FR-LTI in mining to be $900,000 USD.

⁵RSST - Estimating the Costs of Occupational Injuries - A Feasibility Study in the Mining Industry, 2013, extrapolated for inflation and currency difference

⁶Hubler et al., 2012

Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules. Hursh et al., 2004
Calculating the Benefits: 
Task Assignment Optimization

Having calculated the benefits of Readi’s Fatigue Reduction, we now calculate the additional benefits provided by Readi’s Task Assignment Optimization.

This calculation involves 2 major steps:

1. Determine how the operation’s Fatigue Risk Profile changes on account of Task Assignment Optimization.
2. Calculate the projected change in productivity and safety vs. the previous scenario.

**Step 1**

While Readi’s “Fatigue Reductions” change an operation’s overall Fatigue Risk Profile, “Task Assignment Optimization” functions differently.

Instead of changing overall fatigue levels, this method improves the allocation of fatigue risk between Safety-Sensitive and Non-Safety-Sensitive tasks.

In other words, what changes is the type of task each operator may perform, based on their fatigue level. Using predictive data, a supervisor may re-assign complex, safety-sensitive tasks away from critically-fatigued operators.

To model the change in task assignment, we will return to our general assumption that 90% of time spent at a mine site involves “Safety-Sensitive” tasks, and that the remaining 10% of time involves “Non-Safety-Sensitive” tasks. The split will vary by operation, but we believe it is a useful general assumption.

Starting with the Fatigue Risk Profile from the previous scenario (“Scenario 1”), we model the 90/10 split in work hours as follows:

<table>
<thead>
<tr>
<th>ReadiScore Zone</th>
<th>All Work Hours</th>
<th>90% Safety-Sensitive Hours</th>
<th>10% Non-Safety-Sensitive Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 – 100</td>
<td>410,000</td>
<td>369,000</td>
<td>41,000</td>
</tr>
<tr>
<td>80 – 90</td>
<td>648,000</td>
<td>583,200</td>
<td>64,800</td>
</tr>
<tr>
<td>70 – 80</td>
<td>454,800</td>
<td>409,320</td>
<td>45,480</td>
</tr>
<tr>
<td>60 – 70</td>
<td>270,000</td>
<td>243,000</td>
<td>27,000</td>
</tr>
<tr>
<td>0 – 60</td>
<td>217,200</td>
<td>195,480</td>
<td>21,720</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,000,000</strong></td>
<td><strong>1,800,000</strong></td>
<td><strong>200,000</strong></td>
</tr>
</tbody>
</table>

Then, we model the task re-assignment as an exchange of work hours across ReadiScore zones:

<table>
<thead>
<tr>
<th>ReadiScore Zone</th>
<th>Hours Diverted from Safety-Sensitive</th>
<th>Hours Diverted from Non-Safety Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 – 100</td>
<td>(40,000)</td>
<td>(40,000)</td>
</tr>
<tr>
<td>80 – 90</td>
<td>(65,000)</td>
<td>(65,000)</td>
</tr>
<tr>
<td>70 – 80</td>
<td>(46,000)</td>
<td>(46,000)</td>
</tr>
<tr>
<td>60 – 70</td>
<td>(151,000)</td>
<td>(151,000)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>(151,000)</td>
<td>(151,000)</td>
</tr>
</tbody>
</table>
The result is a Fatigue Risk Profile for “Scenario 3”.

Here, the overall amount of fatigue risk is the same, but the amount of “High” and “Severe” fatigue risk is decreased in “Safety-Sensitive” work hours, and it is increased correspondingly in “Non-Safety-Sensitive” work hours.

From there, we follow the same method as in the previous analysis in order to calculate the projected benefits to productivity and safety.

We multiply the number of Safety-Sensitive work hours in each ReadiScore range by the corresponding “per-hour” metrics for productivity and LTI’s.

Compared to the previous scenario (“Scenario 2”), we project the following benefits attributable to Task Assignment Optimization from Readi FMIS, per site annually:

- Increase of $2.27M in output
- Decrease of 0.19 LTI’s
- Decrease of $168K in LTI costs

<table>
<thead>
<tr>
<th>ReadiScore Zone</th>
<th>Hours Worked</th>
<th>Implied Output ($M)</th>
<th>Implied FR-LTIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 – 100</td>
<td>410,000</td>
<td>$ 209.43</td>
<td>0.04</td>
</tr>
<tr>
<td>80 – 90</td>
<td>648,000</td>
<td>$ 326.99</td>
<td>0.35</td>
</tr>
<tr>
<td>70 – 80</td>
<td>454,800</td>
<td>$ 227.25</td>
<td>0.34</td>
</tr>
<tr>
<td>60 – 70</td>
<td>243,000</td>
<td>$ 120.22</td>
<td>0.37</td>
</tr>
<tr>
<td>0 – 60</td>
<td>44,200</td>
<td>$ 21.65</td>
<td>0.08</td>
</tr>
<tr>
<td>Overall</td>
<td>1,800,000</td>
<td>$ 905.53</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Improvement vs. Scenario 2: $ 2.27 (0.19)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>FR-LTI</th>
<th>FR-LTI Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 2</td>
<td>1.37</td>
<td>$ 1,229,568</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>1.18</td>
<td>$ 1,061,120</td>
</tr>
<tr>
<td>Difference</td>
<td>(0.19)</td>
<td>($168,448)</td>
</tr>
<tr>
<td>Difference</td>
<td>-14%</td>
<td></td>
</tr>
</tbody>
</table>
Readi

Trusted and Deployed Globally
Relied on by Global Leaders in Heavy Industry, Transportation, and Military

Rio Tinto
Newmont
Glencore
Kinross
Thiess
South32
Barrick
Newgold
BHP
Minsur
MMG
Pan American Silver
Marcobre
Total
Lundin Mining
PepsiCo
Petronas
NASA
U.S. Department of Transportation
Federal Aviation Administration
Transport for London
U.S. Air Force