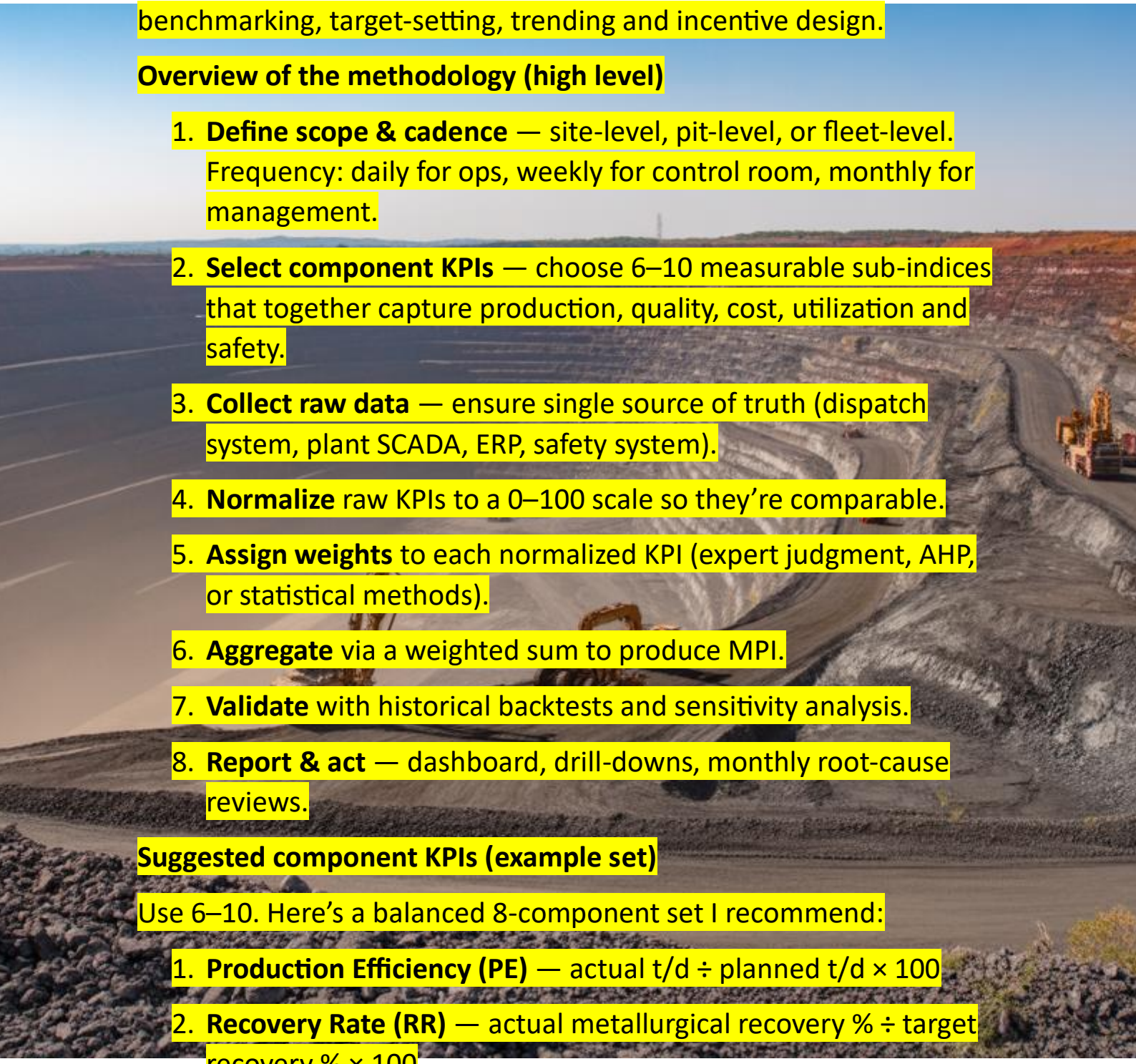
METHODOLOGY TO ESTIMATE MINE PRODUCTIVITY INDEX(MPI)

MPI — a single composite KPI (0–100) that summarizes how productive, efficient, safe and cost-competitive a mine is. Use it for benchmarking, target-setting, trending and incentive design.



Overview of the methodology (high level)

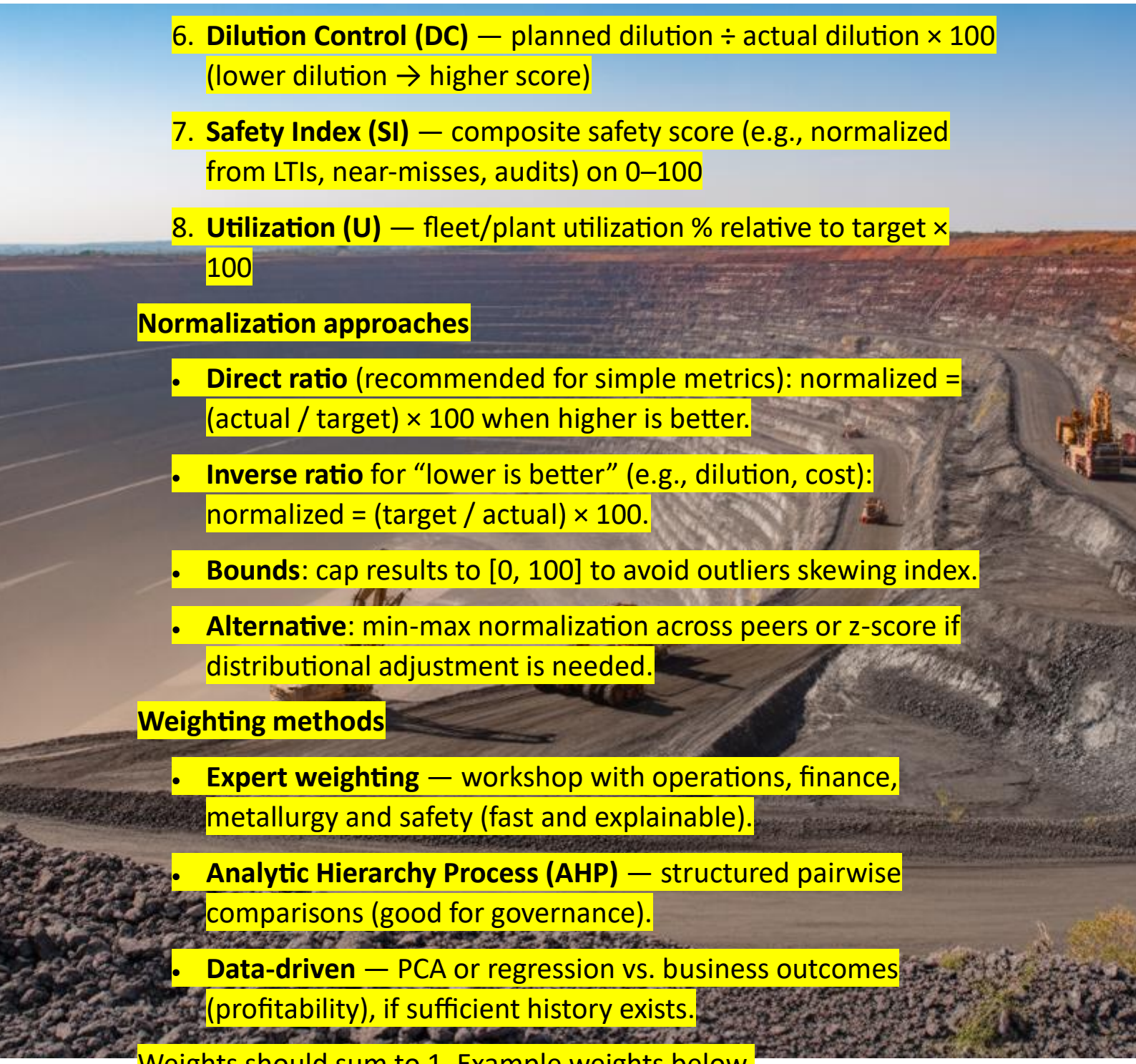
1. **Define scope & cadence** — site-level, pit-level, or fleet-level. Frequency: daily for ops, weekly for control room, monthly for management.
2. **Select component KPIs** — choose 6–10 measurable sub-indices that together capture production, quality, cost, utilization and safety.
3. **Collect raw data** — ensure single source of truth (dispatch system, plant SCADA, ERP, safety system).
4. **Normalize** raw KPIs to a 0–100 scale so they're comparable.
5. **Assign weights** to each normalized KPI (expert judgment, AHP, or statistical methods).
6. **Aggregate** via a weighted sum to produce MPI.
7. **Validate** with historical backtests and sensitivity analysis.
8. **Report & act** — dashboard, drill-downs, monthly root-cause reviews.

Suggested component KPIs (example set)

Use 6–10. Here's a balanced 8-component set I recommend:

1. **Production Efficiency (PE)** — actual t/d ÷ planned t/d × 100
2. **Recovery Rate (RR)** — actual metallurgical recovery % ÷ target recovery % × 100
3. **OEE (Equipment Overall Efficiency)** — availability × performance × quality (as %)

4. **Cost Efficiency (CE)** — benchmark cost/tonne ÷ actual cost/tonne × 100 (higher is better)
5. **Grade Consistency (GC)** — actual grade ÷ planned grade × 100
6. **Dilution Control (DC)** — planned dilution ÷ actual dilution × 100 (lower dilution → higher score)
7. **Safety Index (SI)** — composite safety score (e.g., normalized from LTIs, near-misses, audits) on 0–100
8. **Utilization (U)** — fleet/plant utilization % relative to target × 100



Normalization approaches

- **Direct ratio** (recommended for simple metrics): normalized = (actual / target) × 100 when higher is better.
- **Inverse ratio** for "lower is better" (e.g., dilution, cost): normalized = (target / actual) × 100.
- **Bounds**: cap results to [0, 100] to avoid outliers skewing index.
- **Alternative**: min-max normalization across peers or z-score if distributional adjustment is needed.

Weighting methods

- **Expert weighting** — workshop with operations, finance, metallurgy and safety (fast and explainable).
- **Analytic Hierarchy Process (AHP)** — structured pairwise comparisons (good for governance).
- **Data-driven** — PCA or regression vs. business outcomes (profitability), if sufficient history exists.

Weights should sum to 1. Example weights below.

Aggregation formula

Let normalized component scores be (S_i) (0–100) and weights (w_i) (sum = 1).

[
\text{MPI} = \sum_{i=1}^n w_i \times S_i
]

MPI will be in the 0–100 range. You can map ranges to traffic lights:

- 0–59 = Red, 60–79 = Amber, 80–100 = Green

Governance & validation

- **Backtest** MPI vs historical production, cashflow and incident logs.
- **Sensitivity analysis**: vary each weight ±10–20% to see MPI volatility.
- **Drill-down dashboards**: every MPI component should be clickable to source metrics and root causes.
- **Data quality rules**: must meet completeness and sanity checks before MPI is published.

Implementation & reporting

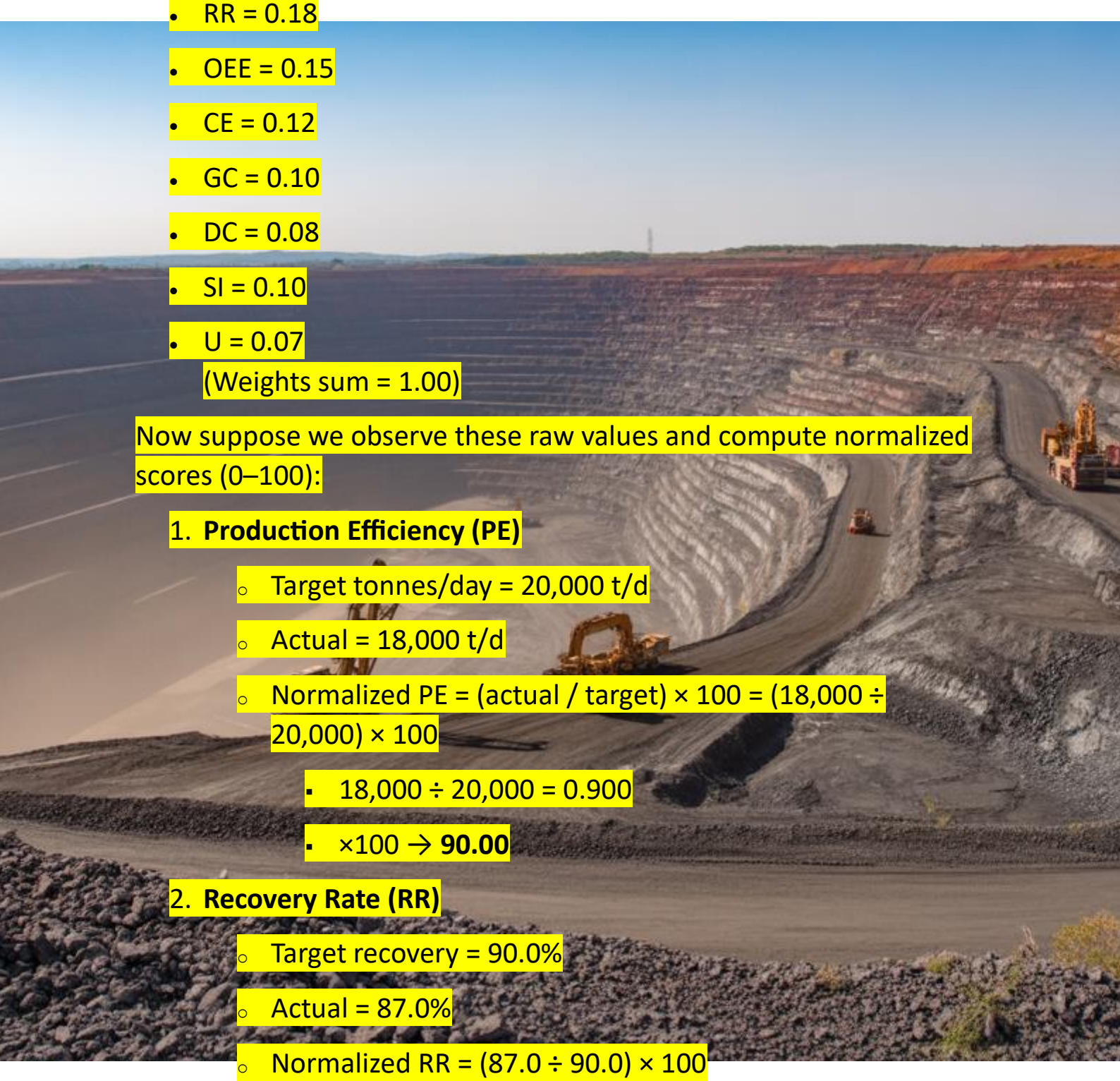
- **Data sources**: fleet telematics, plant SCADA, lab system (LIMS), ERP (cost), safety reports.
- **Frequency**: compute daily for operations; produce weekly summaries and monthly deep dives.
- **Dashboard**: show MPI trend, component breakdown, Pareto of losses, and top 5 actions.
- **Targets & incentives**: tie short-term incentives to component improvement, not just MPI, to avoid gaming.

Worked numeric example (step-by-step)

We'll use the 8 components above with these **example weights**:

- PE = 0.20
- RR = 0.18
- OEE = 0.15
- CE = 0.12
- GC = 0.10
- DC = 0.08
- SI = 0.10
- U = 0.07

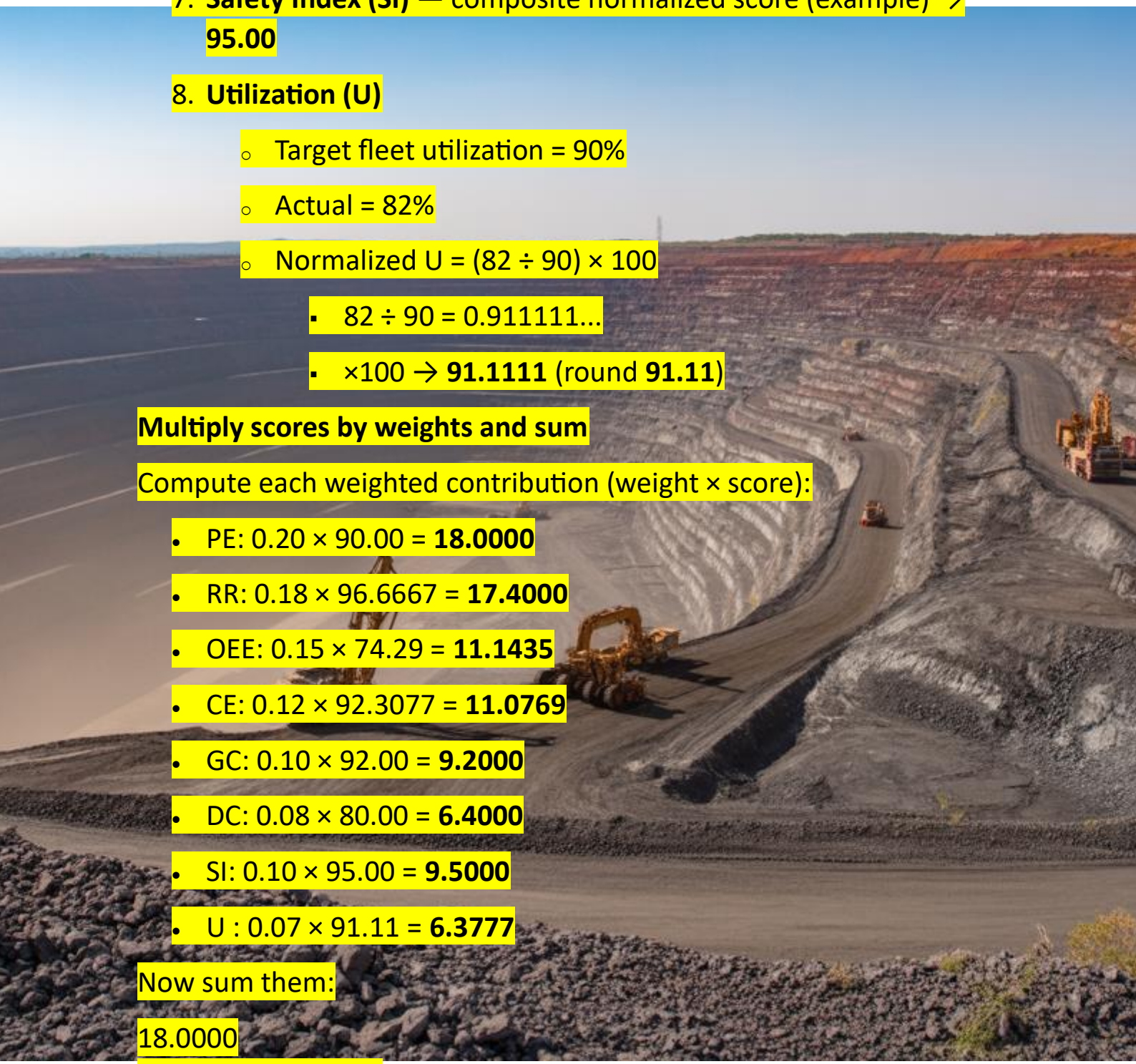
(Weights sum = 1.00)



Now suppose we observe these raw values and compute normalized scores (0–100):

1. **Production Efficiency (PE)**
   - Target tonnes/day = 20,000 t/d
   - Actual = 18,000 t/d
   - Normalized PE = (actual / target) × 100 = (18,000 ÷ 20,000) × 100
     - 18,000 ÷ 20,000 = 0.900
     - ×100 → **90.00**
2. **Recovery Rate (RR)**
   - Target recovery = 90.0%
   - Actual = 87.0%
   - Normalized RR = (87.0 ÷ 90.0) × 100
     - 87.0 ÷ 90.0 = 0.966666...
     - ×100 → **96.6667** (round to **96.67**)

3. **OEE (availability × performance × quality)**
    - Availability = 85% → 0.85
    - Performance = 92% → 0.92
    - Quality = 95% → 0.95
    - OEE (decimal) = 0.85 × 0.92 × 0.95
        - First: 0.85 × 0.92 = 0.78200
        - Then: 0.78200 × 0.95 = 0.74290
        - ×100 → **74.29**
4. **Cost Efficiency (CE)** — lower cost is better, use inverse ratio
    - Benchmark cost/tonne = ₹1,200
    - Actual cost/tonne = ₹1,300
    - Normalized CE = (benchmark ÷ actual) × 100 = (1,200 ÷ 1,300) × 100
        - 1,200 ÷ 1,300 = 0.923076923...
        - ×100 → **92.3077** (round **92.31**)
5. **Grade Consistency (GC)**
    - Planned grade = 2.50%
    - Actual grade = 2.30%
    - Normalized GC = (actual ÷ planned) × 100 = (2.30 ÷ 2.50) × 100
        - 2.30 ÷ 2.50 = 0.92
        - ×100 → **92.00**
6. **Dilution Control (DC)** — lower dilution is better (target 8%, actual 10%)
    - Normalized DC = (target ÷ actual) × 100 = (8 ÷ 10) × 100



- 8 ÷ 10 = 0.8
- ×100 → **80.00**

7. **Safety Index (SI)** — composite normalized score (example) → **95.00**
8. **Utilization (U)**
    - Target fleet utilization = 90%
    - Actual = 82%
    - Normalized U = (82 ÷ 90) × 100
        - 82 ÷ 90 = 0.911111...
        - ×100 → **91.1111** (round **91.11**)

Multiply scores by weights and sum

Compute each weighted contribution (weight × score):

- PE: 0.20 × 90.00 = **18.0000**
- RR: 0.18 × 96.6667 = **17.4000**
- OEE: 0.15 × 74.29 = **11.1435**
- CE: 0.12 × 92.3077 = **11.0769**
- GC: 0.10 × 92.00 = **9.2000**
- DC: 0.08 × 80.00 = **6.4000**
- SI: 0.10 × 95.00 = **9.5000**
- U : 0.07 × 91.11 = **6.3777**

Now sum them:

18.0000
+17.4000 = 35.4000
+11.1435 = 46.5435
+11.0769 = 57.6204

+9.2000 = 66.8204
+6.4000 = 73.2204
+9.5000 = 82.7204
+6.3777 = **89.0981**

MPI = 89.10 (rounded to two decimals)

How to interpret this example

- MPI ≈ **89.1** → “Green” zone (high productivity).

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HEAD OF MINING