The Hidden Cost of Healthcare

Transforming medical equipment management with data and analytics

Why it matters

$60 bn
annual medical equipment spending (U.S.)

30%
of total costs of health systems)

Current practice

"The doctor with the loudest voice gets new equipment"

No data-driven decision like in other industries (e.g. transportation)

HANDLE Global

First to offer a data solution for asset management in healthcare

Question

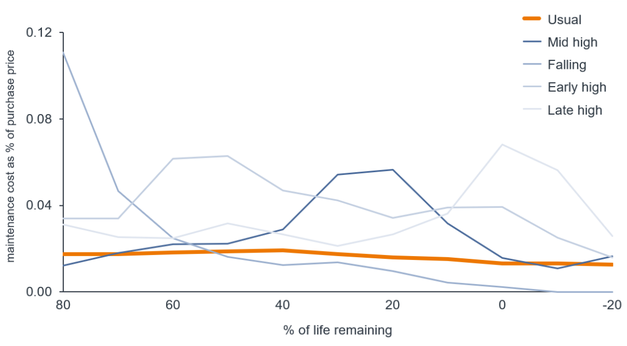
Can we use **historical maintenance data** to provide **decision support** for better asset **replacement strategy?**

Descriptive Analytics

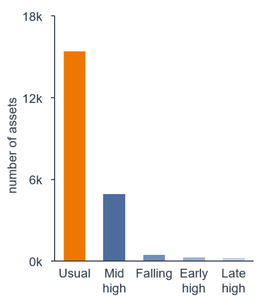
Maintenance cost over lifecycle (clustering)

Time series clustering on maintenance cost aggregated by product/category
Distance metric: Dynamic time wrapping & Euclidean
Method: Agglomerative/hierarchical clustering

Cluster across life cycle



Assets per cluster

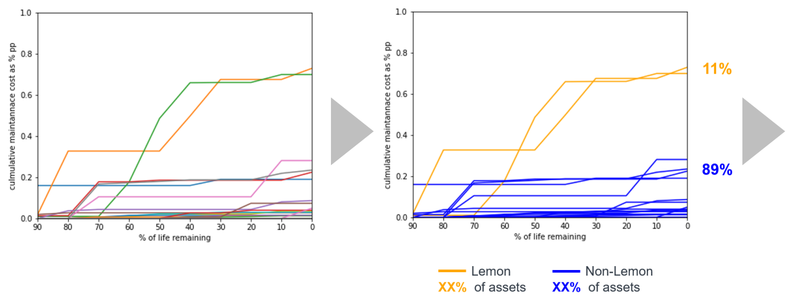


Majority of assets show stable maintenance cost over time

Lemon analysis

Lemon = *asset with significantly higher life-time maintenance cost as its peers*
1- Demeaning of asset maintenance cost to achieve **global comparability**
2- Select global cutoff for lemons - **how much more expensive is a lemon?**

Example Mindray Passport2 (monitor)



Outcome

Handle Product ID Name	Lemon	Non-Lemon
GE Healthcare SENOAdvantage	40%	60%
Philips L157IO	29%	71%
GE Healthcare MAC5500HD	24%	76%
GE Healthcare SAM	23%	77%
Philips L93	22%	78%
Hill-Rom 4802	20%	80%
GE Healthcare M4S	20%	80%
Olympus GIFQ180	20%	80%
Philips FM30	17%	83%
Philips CX50	17%	83%
GE Healthcare E8C	13%	88%
GE Healthcare PRO400	12%	88%
Mindray PASSPORT2	11%	89%

Ranking of product per percentage of lemon

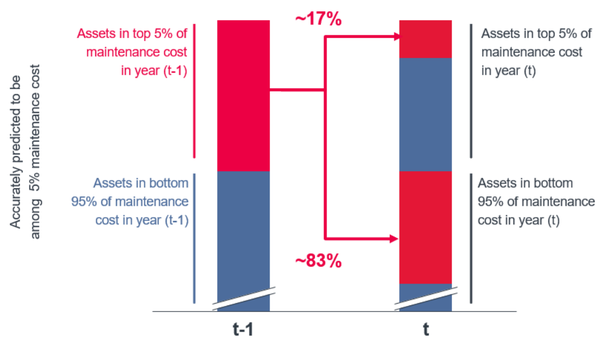
Products can be ranked by relative number of "lemons"

Predictive Analytics

Predictive setup

Predicting expected annual maintenance cost to detect early costly assets.

Comparison of high maintenance assets at t & t-1

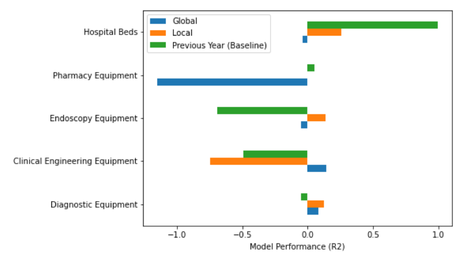


Only ~17% of high maintenance assets in year t-1 are again high maintenance year t. **Disaggregated cost is unstable**

Last year's cost is a bad predictor

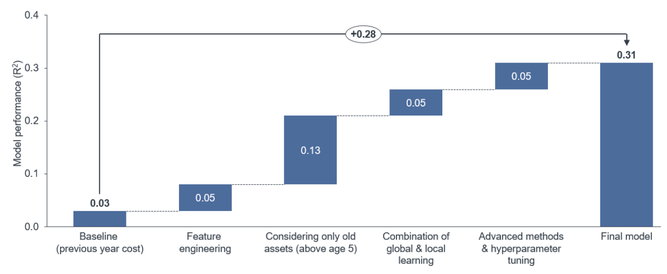
A Global-Local-Baseline (GLB) approach

Example of GLB



For each category, we select the **best predictor** between a **local linear regression**, a **global gradient boosting** and the **previous year's cost**

R^2 improvement

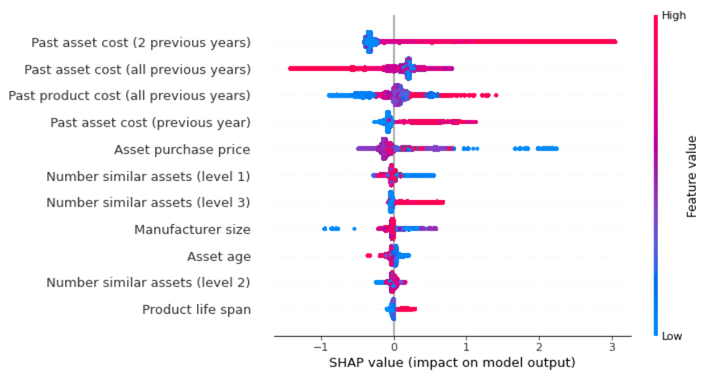


28% R^2 improvement with GLB

Feature importance

Feature importance makes our model more interpretable, but also will guide future data collection and equipment handling.

Shap plot



Asset age is a weak predictor for maintenance cost.

Maintenance cost is predicable with MAE $90 per asset per year

Prescriptive Analytics

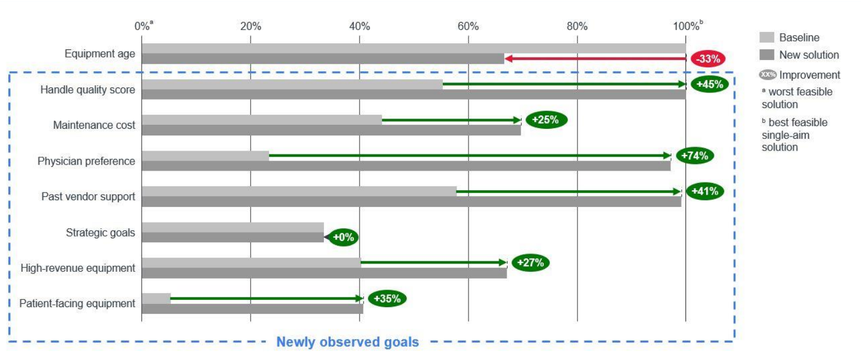
What to optimize for?

HANDLE score: Asset quality
Expected maintenance cost: Cost and reliability
Physician preference: Physician satisfaction
Past vendor support: Risk of higher replacement effort
Strategic goals: E.g. Standardization
High-revenue equipment: Risk of revenue-loss
Patient-facing equipment: Patient experience

Technique:

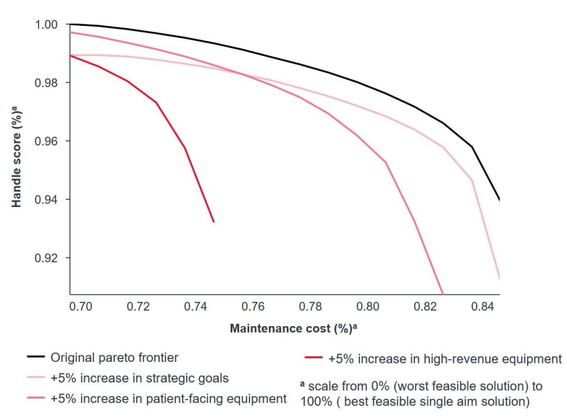
- **Iteration over objectives** to find **Pareto optimal** solution
- **Relaxation** of binary constrain for better scalability

Improvement



15% increased capital-effectiveness

Trade-off analysis



Pareto frontier to illustrate trade-offs between multiple objectives

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