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Canadian Electricity Association | Association canadienne de l'électricité

Asset Health Indices

A utility industry necessity

Contents

Introduction

This whitepaper has been developed by Deloitte's Asset Management team, working in conjunction with the Canadian Electricity Association (CEA). The aim of the whitepaper is to provide view point of the current usage of Asset Health Indices in Canadian utilities, to provide an indication of best practices, and to generate a roadmap for companies wishing to adopt more advanced asset health practices.

Making the decision to implement Asset Health Indices is a significant move for any organization. We intend this whitepaper to advance the asset management efforts of organizations, leading to optimized maintenance practices, improved network reliability, customer satisfaction, and business efficiency.

A representative sample of 15 Canadian utility companies were interviewed in the development of this whitepaper. They were asked a range of questions regarding Asset Health Indices, such as:

- What are your current Asset Health Indexing practices?
- How did you develop your Asset Health Index?
- What issues did you face in implementing your Asset Health Index and how were they solved?
- How did you justify the cost and effort of building your Asset Health Index?

From these interviews, as well as cross-industry trending information, and practice knowledge, this whitepaper outlines:

- How data can be used to develop Asset Health Indices
- Why an Asset Health Index drives efficient and effective business operations
- The definition and purpose of an Asset Health Index
- How to formulate an Asset Health Index
- The maturity scale of organizations using Asset Health Indicators to assess condition and risk
- How to evolve along the scale

About the Canadian Electricity Association

Founded in 1891, the Canadian Electricity Association (CEA) is the national forum and voice of the evolving electricity business in Canada. The association contributes to the regional, national and international success of its members through the delivery of quality value-added services.

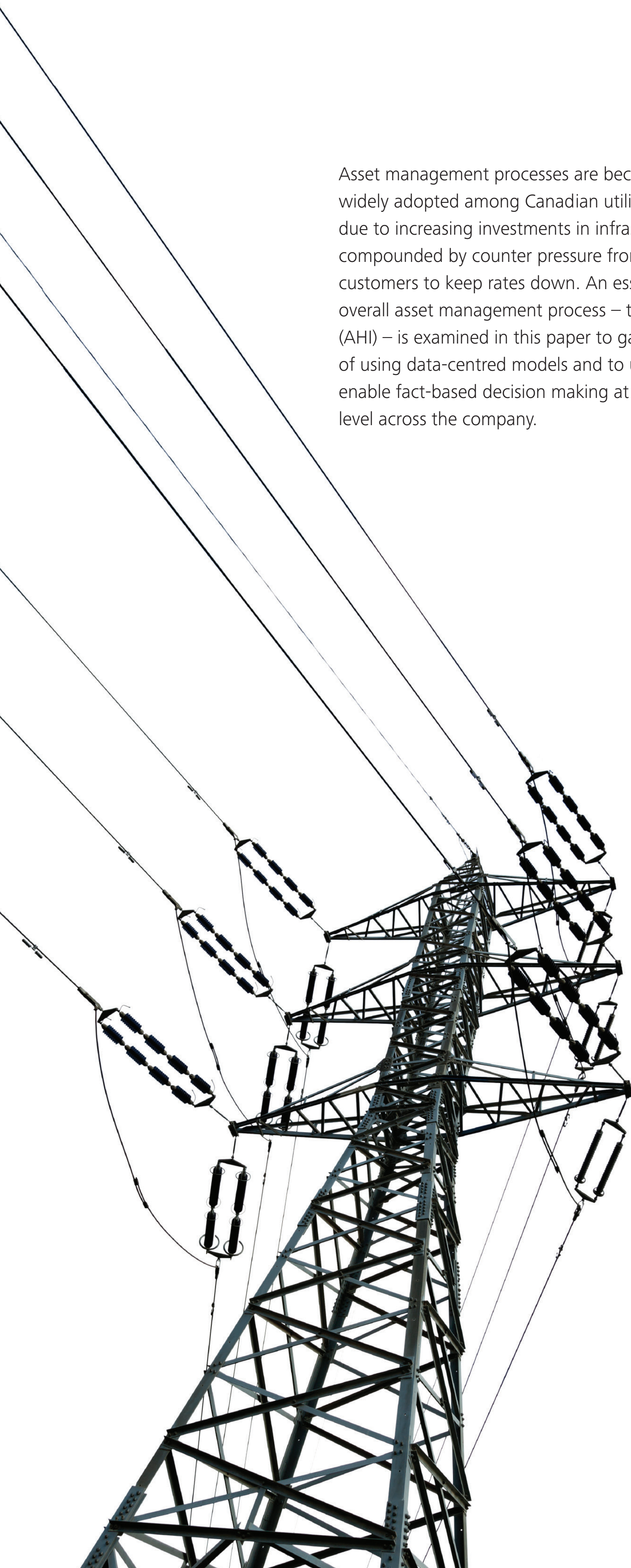
Within CEA, there are several different councils, committees and working groups, each focusing on a particular area of the electric utility industry. This paper has been written in collaboration with CEA's Service Continuity Committee (SCC). The SCC is dedicated to improving the reliability of the distribution system of the electricity industry through the analysis of outage data. With the study of Asset Health Indexing, the committee expects to improve reliability by improving asset management processes.

About Deloitte

Deloitte's Asset Management practice is focused on developing robust value-based asset management processes for asset intensive industries including Power & Utilities and Oil & Gas, using an industry proven Asset management methodology. Deloitte has a well-established power and utilities practice, capable of providing clients with:

- Expert advice on PAS55 & ISO55000 and related capabilities assessments
- Analytics services through our Global Deloitte Analytics Capabilities
- Linkage of Asset Management practices with Operations Excellence initiatives

Purpose of the study



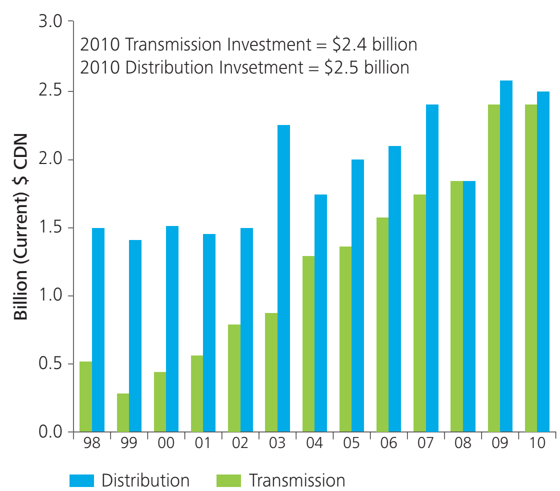
Asset management processes are becoming more widely adopted among Canadian utilities, in part due to increasing investments in infrastructure assets compounded by counter pressure from regulators and customers to keep rates down. An essential aspect of the overall asset management process – the Asset Health Index (AHI) – is examined in this paper to gauge the prevalence of using data-centred models and to understand how they enable fact-based decision making at the asset portfolio level across the company.

Success factors

Some utilities have been successful in addressing the needs and costs of their infrastructure assets. They have decreased their maintenance backlog, received funding, and improved system reliability.[1] These utilities have a few things in common:

- They have a deep understanding of the condition of their assets, today and 20 years into the future
- They know how the condition of their assets impacts system reliability
- They articulate conditions and risk in a clear way to regulators and stakeholders
- They focus budget discussions on risk/reliability, rather than on project costs

Utility investment in Canada's transmission and distribution cable and lines, 1998-2010



Source: Statistics Canada, Survey 2803, 2009
Source: CEA member reporting data for years 2008-2010, based on 2010 Sustainable Electricity Annual Report
Note: Statistics Canada and CEA member data combined

[1] Based on interviews with Canadian utilities

Drivers of change

- Spending on Canadian utility assets has been trending upwards over the last 10 years.[2] Based on Conference Board of Canada estimates, Canada will require $294 billion in electricity investment by 2030.
- A large portion of infrastructure assets across Canada are nearing their end-of-life or require significant maintenance investments to maintain consistent levels of reliability. At the same time, pressure is building to keep costs to a minimum and customer rates low. A "perfect storm" is brewing with the growing backlog of maintenance work and minimal funding increases to deal with it.
- In some Canadian provinces, regulators are demanding detailed analysis and justification for budgets being submitted by utilities. They are requiring information about asset health and condition, as well as long term views about necessary maintenance activities and system reliability. To meet these demands, utilities must implement Asset Health Indices.
- Most utilities have invested significant amounts of time and money collecting and storing data. Utilizing this data in Asset Health Index calculations and asset management practices in general puts the data to good use, providing a return on investment for the initial set-up costs.
- There is significant pressure from regulators and customers to keep rates down. At the same time, assets are aging and require investment in their maintenance. Utilities can balance these competing factors by getting smarter with maintenance activities. Leveraging analytics along with a data-driven Asset Health Index will support a condition-based and reliability-centred maintenance approach.
- An aging workforce means tacit knowledge is leaving organizations. Moving towards data-driven decision making using Asset Health Indices helps to capture that knowledge before it leaves the organization.
- Aging assets are causing an increasing number of "emergency" work activities, which cost more and are harder to manage. Moving to proactive or predictive maintenance enables better workforce planning, which leads to reduced costs.

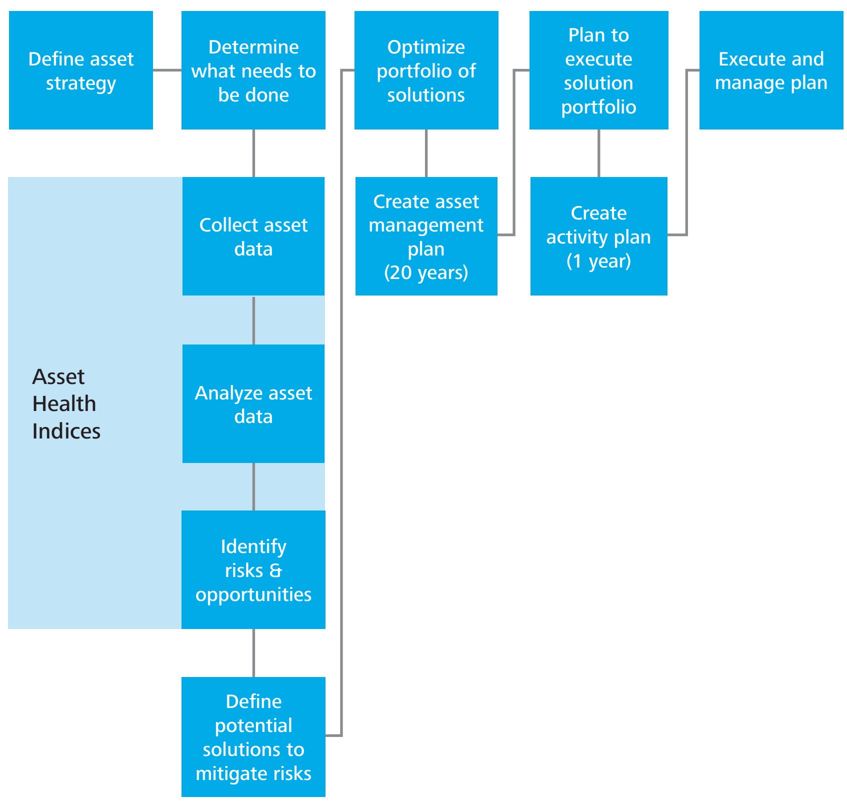
Asset management process

In order to clearly articulate condition and risk of assets, it is imperative to first understand the components of a sound asset management process.

At the very highest level, asset management can be considered as a series of processes and tools that examine, analyze and prioritize assets and the work done on those assets, across an organization.

This whitepaper examines an important section of the overall asset management process – the **Asset Health Index** (AHI).

Illustrative Asset Management process



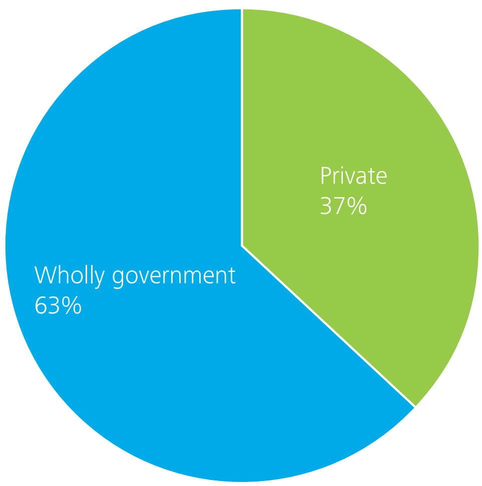
[2] Based on Conference Board of Canada estimates – provided by CEA

Key members of CEA contributing to the study

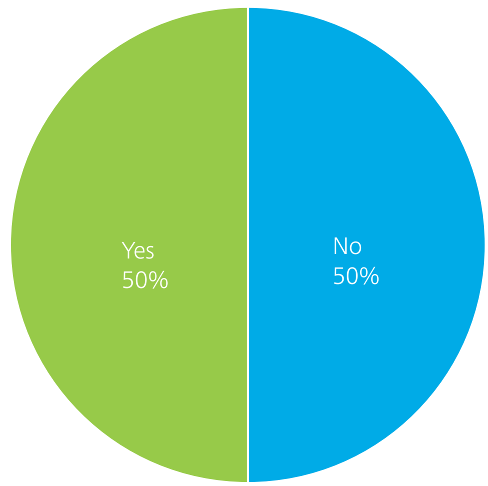
To gain insight into the Canadian utility industry, we conducted interviews with 15 electric utilities across Canada, focusing mainly on transmission and distribution companies. These companies control over $115 billion in asset value combined, and 60% of them are government-owned.

Of these 15 companies, half are currently using some form of Asset Health Indexing in their business. The other half are planning for it, thinking about it, or trying to figure out how to get started. This is clearly an area of rapidly growing importance for Canadian utilities, and one that warrants further attention.

Ownership type



Utilities currently using Asset Health Indices



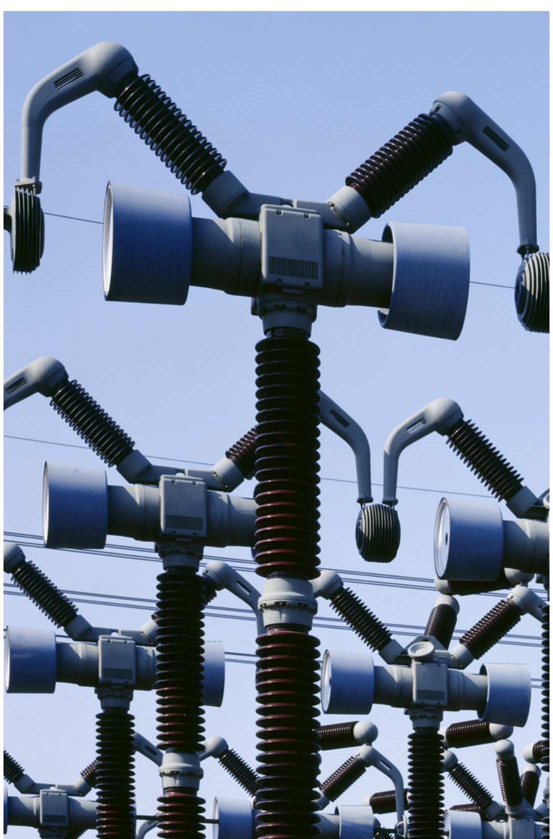
The descriptions, examples, and models described in this paper are largely derived from the interviews with these utilities, and some additional research conducted by the authors. During the course of the interviews, Utilities discussed their Asset Health Index practices, and touched on the key factors that are driving change in their organization, and in the broader market. This paper summarizes these interviews and information and has pulled out the key themes and trends that were common. Deloitte has mapped the results to an Asset Health Index Maturity Model.

What is an Asset Health Index?

Big Data.
Asset Analytics.
Asset Health Indices.
Asset Management.

These terms are sprouting up everywhere today, no doubt fuelled by the latest technology systems streaming massive amounts of data into the hands of organizations and their stakeholders. Assets of electric utility companies are not excluded from the impact of the data revolution. The amount of data being collected is growing exponentially along with the increasing ability of utilities to track and monitor assets – building expectations to do something with that data.

Many organizations excel at data collection, but few manage to use the data in a meaningful way. This whitepaper will provide an overview of how data can be used to develop Asset Health Indices, which are a powerful tool in running a business in an efficient and effective manner.



Asset Health Indices can also be referred to as:

- **Equipment Health Rating (EHR)**
- **Asset Condition Assessment (ACA)**
- **Asset Condition Index (ACI)**

Essentially, an Asset Health Index can be defined as:

- A way of measuring the overall health of an asset
- A list of data parameters for an asset that feed into a calculated health rating
- A way of comparing different assets and asset classes in a consistent manner
- An output of Big Data and asset analytics
- An input, or building block, to a broader asset management process

AHIs are comprised of large amounts of specific data parameters for an asset that is summarized into a number – the Asset Health Index (AHI) rating – typically ranging from 1-10 where 1 is an asset in “new” condition, and 10 is an asset that could fail at any moment.

If designed correctly, AHIs will be the bridge between Big Data and asset management systems, and should help to answer important questions such as:

Questions AHI's will help to answer

Which assets should be replaced vs. repaired?
As part of a broader asset management process, Asset Health Index information helps to sort through potentially thousands of assets and enable an Asset Manager to focus attention on the assets that are in the worst condition first.

When should assets be replaced?
AHI ratings will, by their nature, indicate how urgently assets should be repaired or replaced. The higher the rating, the more urgently the asset needs attention (keeping in mind that asset management process also factor in risk levels and other corporate priorities which may override purely condition based decisions)

What trends are evident in each asset class?
Comparing the same data points for multiple transformers or wood poles will reveal insights and trends that were either not previously evident, or based on "feelings" from experienced field engineers, but not verified with facts.

What trends are visible across the asset portfolio?
Do certain geographic regions wear out asset faster? Do certain contractors have a positive or negative impact on the assets they maintain? If so, how do you approach them? Clear data trends and facts are a more solid basis for discussions on how to mitigate issues like these.

Can predictions be made on future asset failures?
Analysing failure modes and conducting root cause analysis will provide insight into the conditions leading up to asset failures. Once the factors leading to failures are known, assets can start to be monitored for those factors, and repaired prior to failure.

Can maintenance activities be optimized to reduce overall expenditures?
If asset failures can be predicted before they happen, and work schedules can be given a month or two in advance, overtime should be reduced, emergency repairs are minimized, and costs will be reduced. Many examples can be provided where expenditures have been reduced by up to 20% or more through installing rigorous asset management processes.

Elements of an Asset Health Index

As a rule of thumb, a typical AHI will consist of five or more elements:

1. Asset identification
Manufacturer name, model number/type, date manufactured, date installed, current age, cost of asset, install location (potentially geographic information system (GIS) data)

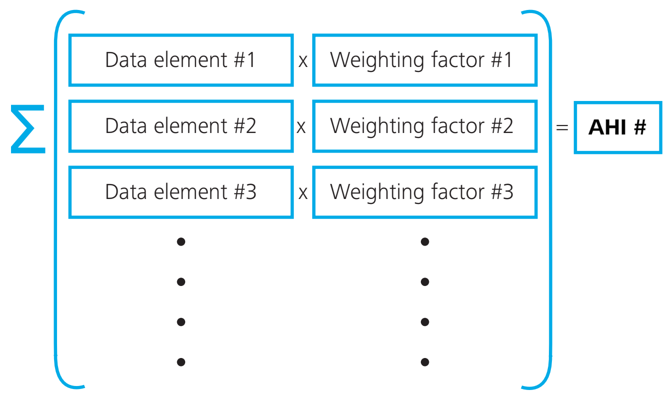
2. Condition
On-site engineering testing and assessments of: Physical attributes, visual inspection results, electronic inspection results

3. Usage
Current usage (i.e. what is a pole holding), loading (i.e. voltage through a transformer compared to maximum rating), stresses

4. Failure modes analysis
Analysis of most common reasons of failure, as well as failure trends and correlations across data sets

5. Criticality/risk information
Criticality of assets relative to one another, and in relation to corporate objectives and risk tolerances. (includes location criticality, asset type criticality, etc.)

These elements form the input to a set of calculations that produces the AHI number. The simplest form of calculations that can be used applies a weighting factor to each data element and sums the results, as shown below:



More advanced AHI calculations manipulate the data elements in various ways, and involve complex data analytics and trending results, possibly leveraging neural network analysis and other advanced methodologies to arrive at the AHI number. Some examples of advanced AHI calculations are provided on page 10.

Which assets require an Asset Health Index?

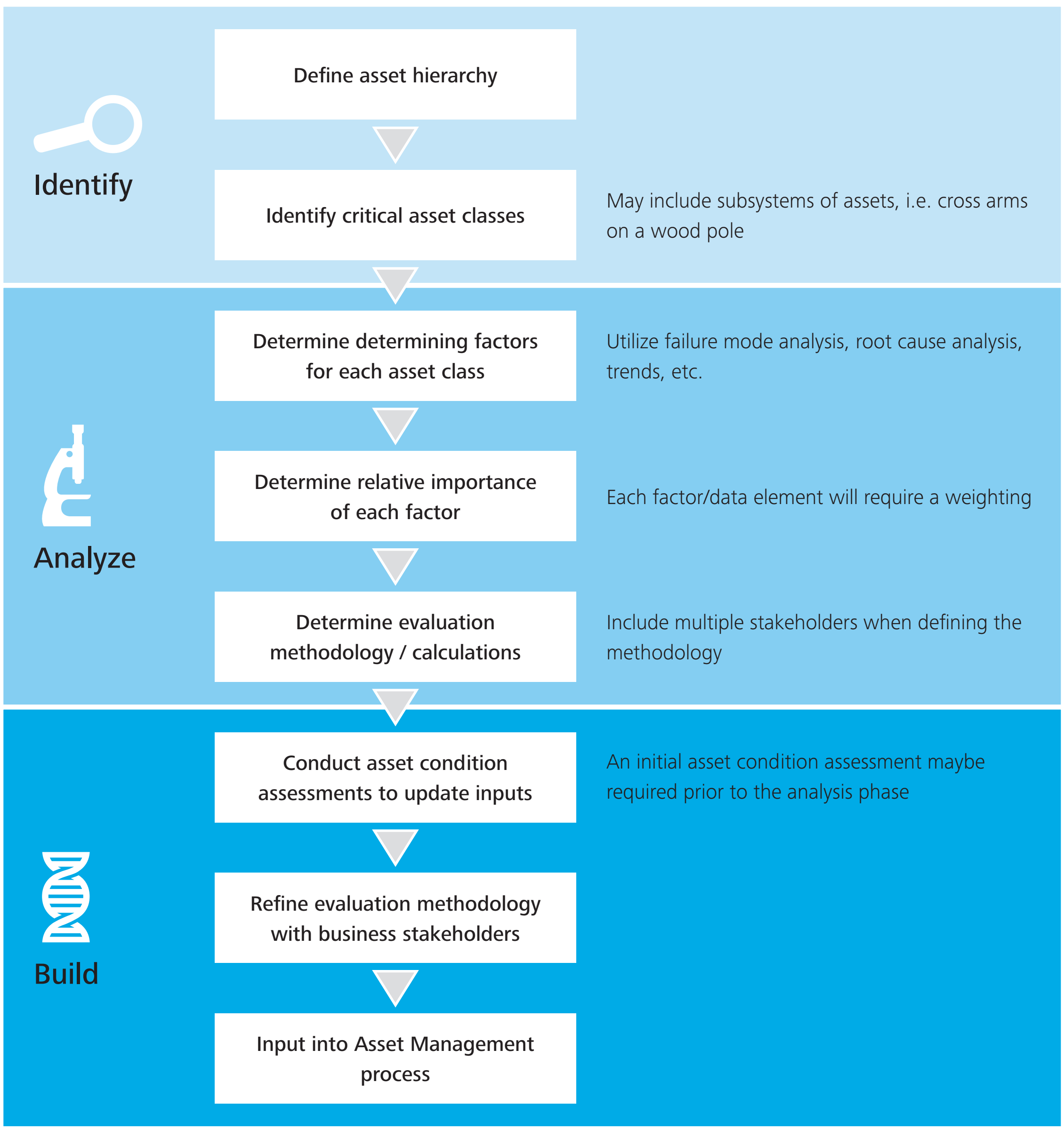
Not every asset needs to be associated with a health index. Typically, utilities will design an AHI for those assets that represent a high risk or will have a high impact if failure occurs. The following assets are generally used in an Asset Health Index:

- Poles (including sub-components such as cross-arms, insulators, guy wires, fittings, arrestors)
- Transformers (pad mount, pole mount)
- Reclosers, breakers, switches
- Cable
- Turbines, generators
- Towers (low and high voltage)
- Facilities (buildings represent a critical asset, with failures impacting many areas of the business)
- IT Infrastructure (i.e., data centres, networking lines, hardware)

Formulating an Asset Health Index

Introduction to a basic Asset Health Index calculation

While there is no standard method for building an Asset Health Index, generally most AHI managers follow the **Identify** —> **Analyze** —> **Build** process, shown below:



Determining critical factors – the role of analytics

During the analysis phase, asset data is organized into five main elements, as described on page 6:

1. Asset identification
2. Condition
3. Usage
4. Failure modes
5. Criticality/risk information

Data analytics specialists look for trends in the data to determine why assets are failing and the causative indicators leading to failure. This information will vary by asset type, and possibly by region or usage.

For example, the following data elements have been used by Canadian utilities as key factors in determining failure modes[3] of wood poles:

- Pole circumference measured at the base of the pole (versus expected circumference for that type of pole)
- Width and depth of woodpecker damage
- Width of shell thickness measured by a drill test at the base of the pole (to determine internal decay)
- Age of the pole, type of wood, and the manufacturer's estimated lifespan
- Angle of conductors on the pole (supports calculations of stresses on the pole)

Some utilities also include the health of individual pole components, including:

- Cross arms
- Insulators
- Guy wires
- Fittings

These individual pole components can be replaced as single parts, and do not necessarily reflect the health of the entire pole. As a sub-component of an asset, their influence on the Asset Health Index should be adjusted to reflect their impact.

Measuring critical factors

Each factor may be a direct measurement or a calculation based on multiple sub-measurements or data elements. For example,

- Pole circumference rating: a calculation of measured circumference divided by the expected circumference
- Shell thickness: direct measurement
- Stress on the pole: calculated based on several sub-components
- Soil and weather rating: determined by overlaying asset GIS data onto soil and historical weather maps

Ideally, each calculation should be based on a consistent scale, from 1-10 or 1-100.

[3] A combination of key factors, as provided by two Canadian utility companies

Determining relative importance

Once the key factors are identified and calculated, it needs to be determined how important they are to the overall health of the asset. Typically, the failure modes analysis and root cause analysis used to determine the key factors will also give an indication of their relative importance. Using the wood pole example, the relative importance assessment follows as:

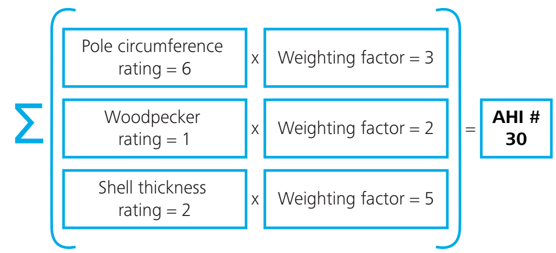
Key factors – direct measure[4]	Weighting
Pole circumference rating	3
Woodpecker damage rating	2
Width of shell thickness	5
Total	**10**

Key factors – indicators[5]	Weighting
Age of the Pole	6
Stress on the Pole	2
Soil type and weather factors	2
Total	**10**

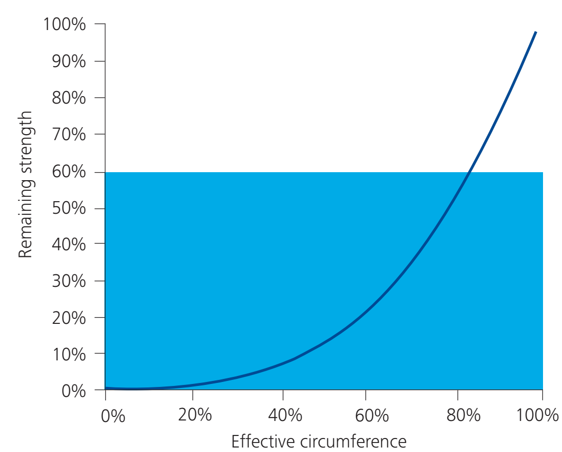
The first three factors are a direct measure of the condition of the asset, while the last three factors are indicators of potential condition. Based on interviews with Canadian utility companies, when direct condition data is available, the indicator factors are not used. However, when direct condition data is not available, the indicator factors can be used with meaningful results.

Defining evaluation calculations

There is no standard way of calculating Asset Health Indices, as each organization will place different values on the various factors involved. Within an organization, multiple stakeholders must come together to help define what is important and how the calculations should be created to result in a consistent approach across an asset class. As a very basic example, the wood pole data (in the chart above) can be formulated into an AHI number by using the following formula:



Other variations of evaluation methodologies can also be used. For example, one utility company[6] combines the pole circumference data, woodpecker effect, and shell thickness to calculate an *effective circumference*. Based on the effective circumference, a per cent remaining strength is determined. Poles with remaining strength of 60% or less are considered end-of-life. The company plans replacement of poles with a remaining strength of 60% or less and prioritizes these projects based on risk.



[4] Direct Measure are those data elements that are taken directly from the asset during an inspection. These are generally considered to be more accurate, as they involve someone dealing with the asset directly to assess condition

[5] Indicators are those data elements that do not involve direct contact with the asset, such as age, location and other such data. These data elements will provide an indication of asset condition (old assets are generally in worse condition that new ones), but will not be asset specific, and will not be as accurate as Direct Measure data elements

[6] Source Confidential

Lessons from the field

There are potential pitfalls that utilities should be aware of when planning to formulate an Asset Health Index.

- Data costs money to collect. Each data element to be measured requires a person in the field conducting the inspection and recording the data. A utility will need to carefully balance their data requirements against their available budget.
- Location and scale of assets influence analytics priorities. Utilities with large asset bases will be able to widely disperse data collection efforts, while smaller utilities will need to concentrate efforts.
- Uncertainty in assessing the conditions of assets can create inconsistency in data collection.
- Inability to judge which data points should be collected to assess asset condition can impact accuracy of ratings.
- Levels of service expected from the assets are not satisfactory.
- Uncertainty of return on investment, cost valuation and financing of replacement/refurbishment of assets can make it difficult to determine relative importance.
- Aging infrastructure and workforce may impact the organization's ability to implement Asset Health Index processes
- Lack of consistent and compatible methods to record, store and reference data can cause errors in the analytics phase.

Keep these key principles in mind :

The AHI should provide a clear indication of the suitability of the asset for ongoing usage.

The AHI should be representative of the overall asset health, rather than sub-components.

The AHI should ideally contain objective and measurable characteristics of asset condition where possible. Indirect measures, such as age, location, etc., can be used in the absence of direct measurable data.

The AHI should be easy to understand and readily accepted within the organization.

Reactive or predictive? The maturity scale

There is a broad spectrum of Asset Health Indexing capabilities among Canadian utility companies, based on the interviews conducted for this whitepaper. To make sense of the differences, an Asset Health Index Maturity Model was developed to characterize the factors of maturity, tabled below.

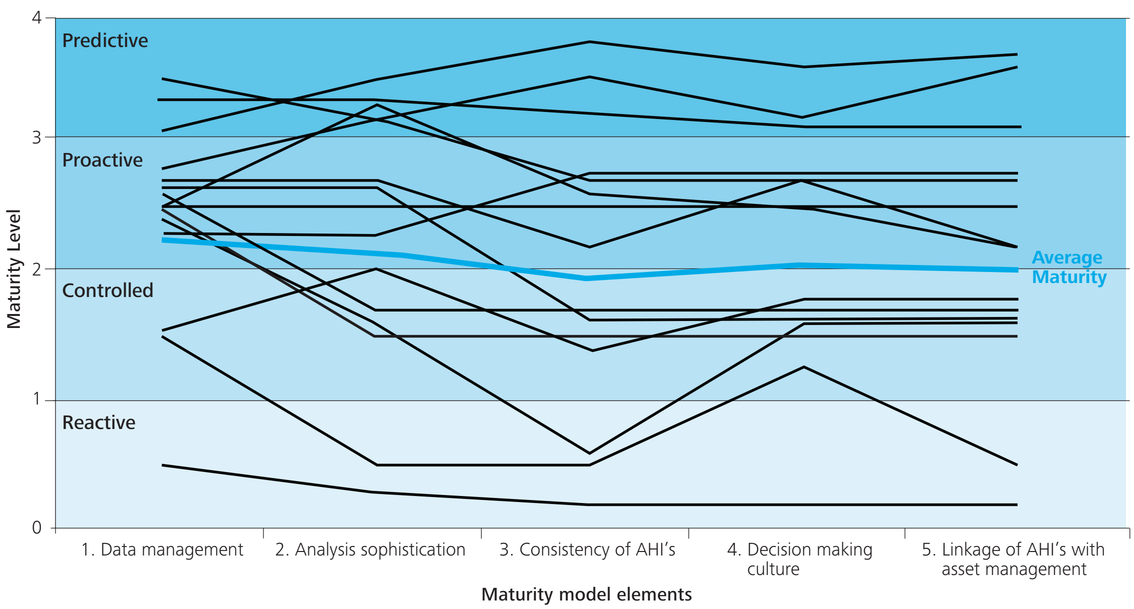
Deloitte's Asset Health Index – maturity model

	1. Data management	2. Analysis sophistication	3. Consistency of AHI's	4. Decision making culture	5. Linkage of AHI's with asset management
Predictive	All data being collected has a defined use within the business. Unnecessary data collection has been stopped. Internal and external data is utilized.	Optimization and simulation of asset condition, leveraging internal/external data and automated sensors	Health Indices are consistent across asset classes	Data-driven, fact-based decision making	AHI's form an integral building block to broader asset management practices, and are regularly updated and improved
Proactive	Abundant data collection, with some analysis of data requirements	Starting to build predictive models with limited set of asset data elements	Health indices are consistently used to compare similar assets	Data-driven decision making with engineering support	Asset Management demonstrates predictive asset analytics
Controlled	Regular/consistent asset data collection	Some operational reports, queries, and key performance indicators (KPIs) are in place.	Some Health Indices are in place but consistency is questioned	Engineer-driven decision making with supporting analysis	Asset Management practices supported by limited analysis
Reactive	Limited or no consistent data on most assets	Limited or no analysis being done, "Fix when broken".	Health Indices not used	Engineer-driven	Ad hoc Asset Management practices in place

State of the nation

Fifteen Canadian utility companies are graphed on the maturity model below. These results represent the authors' impression of the companies interviewed, and does not represent self-selection by the utility companies. Company names have been excluded from the chart.

Maturity model results – Canadian Utilities



From this analysis, it is apparent that there is a large variation in the maturity of AHI's for Canadian Utilities. While some are relatively advanced and well into the Predictive level, others are working at developing the basic steps required at the Reactive level. This is a reflection of the different scales of utilities (asset values ranging from $100M to over $55B) and different regulatory issues faced across the country. In addition, there is a general trend to lower maturity as you move across the model elements. In particular, a large number of utilities have Proactive Data Management, but lower maturity of Analysis and AHI consistency. This is to be expected, as strong Data Management is the first step towards enabling greater sophistication of analysis.

Characteristics of maturity levels

To provide some insight into how to evolve along the scale, the five levels of the model have been examined separately.

Reactive

1. Data management	2. Analysis sophistication	3. Consistency of AHI's	4. Decision making culture	5. Linkage of AHI's with asset management
Limited or no consistent data on most assets	Limited or no analysis being done, "Fix when broken".	Health Indices not used	Engineer-driven	Ad hoc Asset Management practices in place

At the reactive level of the maturity model, companies are not typically focused on building Asset Health Indices, or have not started in a substantial manner. Data collection efforts are limited to specific projects, or areas within the business. If available, data are typically held in spreadsheets or simple databases stored locally.

Limited data collection and usage of that data can be due to a number of factors, including:

- High cost of data collection (both physical testing and data storage/systems)
- Limited scale of assets to distribute data collection efforts, resulting in negative or minimal return on investment (ROI) calculations
- Lack of available resources and specific internal capabilities to conduct testing and collect data

Most decisions are made by tapping the tacit knowledge of the highly experienced workforce, and based on the suggested projects that workforce brings forward to the asset management team or planning team. Typically, there are stories within the organization of "that project that should have been done, but never received funding". Often the reason is simply the project was not individually championed through the budget process.

Controlled

1. Data management	2. Analysis sophistication	3. Consistency of AHI’s	4. Decision making culture	5. Linkage of AHI’s with asset management
Regular/consistent asset data collection	Some operational reports, queries, and KPIs are in place.	Some Health Indices are in place but consistency is questioned	Engineer-driven decision making with supporting analysis	Asset Management practices supported by limited analysis

At this level, companies have started collecting data on several asset classes; in some instances, they are overwhelmed by the volume of data and are uncertain how to use it. This data is typically collected in multiple systems, depending on the asset class, the location of the field crews, and the type of data being collected. For example, visual inspections might be completed using paper forms and then entered into a spreadsheet, while line data is collected automatically in an ERP-type system, generating vast amounts of data points every month. Essentially, at this level, the overriding characteristic is that data collection is inconsistent.

Some asset analytics will be performed at this level, usually limited to one or two different asset types as a pilot program. The analytics performed will consist of various operational reports, trending, and KPI analysis such as:

- Average age of assets, leading to basic age profiles like:
  - Per cent of assets older than expected lifespan
  - Per cent of assets nearing end of expected lifespan
  - Per cent of assets that are relatively young in age (segmented into 10-year spans)

- Number of asset failures per year or month
  - Further broken down by asset identification data to look for trends, such as a particular manufacturer having more failed assets, or a certain region producing more failures

- Basic asset profiles, such as number and types of poles, transformers, switches, etc., and the costs of each, if available
  - Used to determine buying patterns, and potential strategic sourcing opportunities

Some of this information may not be used to build a formal Asset Health Index, but the company will be satisfied they are getting relatively good value from the high cost of data collection.

Proactive

1. Data management	2. Analysis sophistication	3. Consistency of AHI's	4. Decision making culture	5. Linkage of AHI's with asset management
Abundant data collection, with some analysis of data requirements	Starting to build predictive models with limited set of asset data elements	Health indices are consistently used to compare similar assets	Data-driven decision making with engineering support	Asset Management demonstrates predictive asset analytics

At the proactive level, companies are starting to develop more advanced data collection and analytics capabilities, and are using the results in their asset management practices. Data collection is seen as an important activity within the business, and effort is focused on defining what data is necessary. Systems for collecting data are typically more centralized at the intermediate role level, and enterprise wide tools are preferred over spreadsheets. This allows better data security and gives multiple users across the organization access to enter and analyze data, calculate health indices, and generate results.

Asset analytics is generally conducted for all major asset classes, and involves more complex trending analysis than at the controlled stage. For example, companies at the proactive level:

- Record GIS data for some asset classes, and overlay that information onto maps showing historical weather patterns, soil topography, customer demographics, and other information.
  - This type of data analytics can reveal trends that are not possible to identify using only data collected by company engineers and field technicians. Leveraging the power of external GIS data sets to enhance existing internal data greatly increases analytic power, while not incurring significant costs.
- Integrate tracking of maintenance activities on each asset to generate an up-to-date picture of the asset condition, and reveal further trends.
  - Some companies have revealed trends in maintenance activities that actually decreased the expected lifespan of the asset. For example, performing inspections on a transformer can introduce dust and debris into the oil if the transformer is opened, worsening its condition.
  - Matching maintenance tracking with asset failures can also provide insight into contractor performance. For example, transformers with higher failure rates than others could be associated with a certain contractor. This gives the utility an ability to examine the issue further and look for differences between contractors, such as training programs, workforce experience, and overtime.

Performing analytics for each asset class will help define the structure and calculations of the Asset Health Index. Companies should leverage the various failure modes identified through analytics to compose the health index of the factors that matter most.

Predictive

1. Data management	2. Analysis sophistication	3. Consistency of AHI's	4. Decision making culture	5. Linkage of AHI's with asset management
All data being collected has a defined use within the business. Unnecessary data collection has been stopped. Internal and external data is utilized.	Optimization and simulation of asset condition, leveraging internal/external data and automated sensors	Health Indices are consistent across asset classes	Data-driven, fact-based decision making	AHI's form an integral building block to broader asset management practices, and are regularly updated and improved

At the predictive level, Asset Health Indices are an integral part of an organization, and have been developed and refined with the help of multiple stakeholders in the company.

Data collection efforts are starting to reduce, as a result of detailed asset analytics and failure modes analysis defining what data is necessary to collect, and what data is not being used. For example, a large multinational oil company, which once collected over 30,000 data elements to track and manage their assets, reduced their collection efforts to about 16,000 data elements through improved analytics, and by clearly defining their AHIs and data needs. This example highlights the significant amount of excess data companies may be collecting. The cost of that extra data collection can make a significant difference to an organization's bottom line.

One of the biggest differences in Asset Health Indices at the predictive level is the consistency of AHIs across various asset classes. While the underlying calculations may be different for each asset class, the resulting health index score is comparable. In this way, switchgear can be accurately and confidently compared with wood poles or any other type of major asset. This level of comparison opens up significant advances in the asset management efforts of organizations.

When AHIs can be compared across asset classes, it develops the organization's ability to accurately view its entire portfolio of assets. The organization can start taking a holistic approach to managing assets, and determine which are in greater need of repair or replacement. Decisions can be based on the health or associated risk of all assets at once.

Evolving your organization's AHI maturity level

It takes considerable individual effort and determination, along with senior level sponsorship, to advance toward an advanced Asset Health Index practice. Building a business case that clearly articulates the ROI of an AHI can help offset the concern of cost and effort involved. Some key points and ideas are provided to support utilities in their journey.

1. Data management

Moving from reactive to controlled

Field engineers can record basic asset condition data while performing scheduled maintenance activities. By providing field engineers with an understanding of what data is required, they can collect basic information over the course of their regular job using an asset inspection template. Collection can be done using paper-based forms, spreadsheets, or any other means available to the field workers.

This data can be collected and entered into one spreadsheet for each asset class, which can become the starting point for a basic Asset Health Index.

The key to getting to the next level of maturity is achieving regular and consistent asset data collection.

Moving from controlled to proactive

The main difference between Controlled and Proactive levels of data management techniques is applying some level of effort to determine what the actual data requirements are. This sounds simple, but requires the company to begin to think longer term, about HOW the data will be used. Typically, data will be collected to build an Asset Health Index, which in turn feeds into a broader asset management framework to enable fact-based decision making at the asset portfolio level across the company. This narrows the data requirements to those elements that are useful in the Asset Health Index calculation, and potentially in the company wide portfolio management of the assets.

At this point, many companies may believe that all data collected is important, however the cost of data collection must be factored in, and a balance found.

To get to the next level, an organization must begin to look at their data requirements in a proactive way, and begin to narrow the scope of data collection in one or two trial areas.

Moving from proactive to predictive

The shift to predictive data management can be considered a step change. The key for utilities is to develop clear definitions and usages for each data element. Ultimately, this will reduce time and effort spent in collecting unnecessary data elements, and reinforces the important work of field crews in testing essential factors.

While data collected internally is important, it is equally important to start leveraging available external data to supplement asset analytics efforts. Overlaying weather patterns or other geophysical data onto asset data can provide significant insights into asset deterioration causes. For example[7], one utility company realized they had a higher maintenance spend and shorter lifespan on some of their assets. After overlaying wind patterns and wind strengths onto asset GIS data, they learned that strong wind storms were affecting a certain region of the province. Assets in that region were purchased in bulk with the rest of the provincial assets, but were not suited for the harsh conditions. As a result, this company was able to slowly change the assets in that region with stronger, more resistant ones. This program initially cost more, but the company focused on the long term gain to be realized by reduced maintenance and increased system reliability for customers. That type of result would not be possible without leveraging the external wind pattern data source.

[7] Source Confidential

2. Analysis sophistication

Moving from reactive to controlled

Analyzing spreadsheets of asset health information can lead to significant insights into failure modes and other asset trends. Data should be organized in a way that allows for comparison of multiple assets, and if possible, trending over time. For example, keeping track of which assets are failing in a given year and documenting their respective manufacturers may reveal there are external issues impacting the health of assets. Engineers may already know this intuitively, but having the data can validate their gut feel and ease the difficult discussions.

Moving from controlled to proactive

Companies will need to expand their asset analytic efforts to include predictive analytics on some assets. This is an important step as the company experiences a "first" in using data to determine future needs, not just to support current needs.

The "remaining strength" of a wood pole (page 10) is an example of analyzing data to predict future work requirements. Other examples include trending analysis to determine indicator factors leading up to failures. If those indicators are discovered, that asset can be scheduled for maintenance or replacement before it fails.

Moving from proactive to predictive

Continue refining and maintaining up-to-date asset analytics, including root cause analysis, failure mode analysis, and trending analysis among others. Using external data sources, such as geographical data, historical and predicted weather patterns, and customer demographics can enhance internal asset data. Overlaying this external data with asset GIS data allows for better understanding of the underlying information. This more advanced analysis will enable simulation and optimization of asset conditions that are more accurate.

3. Consistency of AHIs

Moving from reactive to controlled

At a minimum, tracking assets in a basic spreadsheet will begin to highlight any data gaps that need filling. It's recommended to work closely with field crews to ensure they understand what data is required, and that it is important to record all data fields to enable accurate analysis.

Through the application of basic health index calculations on a spreadsheet, a company is "forced" to apply consistent comparisons for all assets using the same formula. Even if the accuracy isn't perfect, it still provides a guide that allows decisions to be made in a fact-based manner and not motivated by personal preferences, or "the loudest speaker".

Moving from controlled to proactive

Getting to the Proactive level means refining each Asset Health Index so that similar assets can be compared in a consistent and reliable manner. For example, all wood poles should have an accurate health index using a scale of 1-10 (or whatever scale is chosen) where all poles at an AHI value of 7 will be of similar condition. Anyone in the organization should be able to look at two poles of the same value, and agree that they are of similar condition.

This seems like a straightforward step, but getting alignment among numerous stakeholders in the organization, and accounting for outliers in the analysis can be more work than first anticipated.

Moving from proactive to predictive

At the advanced stage of the maturity model, AHI's should be developed for all major asset types in a comparable manner. For example, if a scale of 1-10 is used for all AHI's, then a transformer with a score of 9 is agreed to be in worse condition than switchgear with an AHI score of 8.

As mentioned in the previous level, this seems like a straightforward step, but getting alignment among numerous stakeholders in the organization, and accounting for outliers in the analysis can be more work than first anticipated. It typically requires an iterative process where the Asset Health Index is formulated, then checked with the field crews for accuracy. If discrepancies are found, the formulation for creating the Asset Health Index can be refined to eliminate the discrepancy.

4. Decision making culture

Moving from reactive to controlled

In order to move to the next level, decision making needs to leverage more than the tacit knowledge of the engineering and field crews. While still very important, engineering business cases need to be supported by broader analysis which looks at multiple assets. The organization leverages the data and analysis performed on the assets to reinforce and enhance the existing engineering knowledge. This combination of sources, using Engineering knowledge and data analysis provides a greater level of project justification and organization buy-in for the decisions being made.

Moving from controlled to proactive

Trust in Asset Health Indices is built by including the engineers, field technicians, and other stakeholders in the development of the index, alongside the Asset Management or Data Analytics team driving the work. The more involvement the engineers, etc. have in the design and calculations, the more they will trust and support the final result.

Once trust in the AHI's is built (and engineers, field technicians, and managers know they can rely on the data being presented), the next step is to establish them as a vital part of the business. To do this, employees need to understand that the work they are doing in preparing the AHI's is going towards something bigger, i.e. Asset management. When it is realized that every data point collected is used to plan work activities, and get the best value out of the company assets, people will support the process.

Getting to the Proactive level means building this trust, and getting the company aligned with the idea of a data-driven decisions, supported by engineering knowledge to verify the solutions are accurate.

Moving from proactive to predictive

To get to the Predictive level, the whole organization must understand the purpose of AHI's and support their development and usage.

- Field engineers must understand that every assessment they conduct will be used in portfolio wide planning
- Maintenance planners must understand that every work order issued will change the AHI of a particular asset, which will improve the overall health of the network
- Everyone in an organization will realize that the accuracy and integrity of their Asset Management processes relies on the accuracy and integrity of the data that goes into it

Once the above is in place, an organization moves into data-driven/fact based decision making. The data supplied by engineers and field crews is trusted to be accurate and relevant, to make proper decisions on a portfolio wide level.

5. Linkage of AHI's with Asset Management

Moving from reactive to controlled
At the Reactive stage of the maturity model, Asset Management is typically conducted in an ad hoc manner. Various projects will be submitted to the planning team for inclusion in the asset plan, and those with the loudest voice will have their projects accepted.

To get to the Controlled level of the maturity model, Asset Management and Planning groups will leverage supporting analysis available for each project. This will enhance existing engineering driven business cases with additional justification (such as trending analysis or failure modes analysis), and provide better justification for 1-20 year plans.

Moving from controlled to proactive
As AHI's gain sophistication, Asset Management practices should also gain sophistication. Getting to the Proactive level of the maturity model involves utilizing the results of AHI's in asset management decision making. Organizations will start to leverage the output of the Asset Health Indexes in the strategic planning process, AND operational planning. The asset condition data and other information will form the basis of identifying and qualifying projects within the asset management plan. Engineering knowledge and expertise provides an additional layer of project justification.

Evidence of predictive analytics and asset health condition forecasting should also be present in Asset Plans.

Organizations at the Proactive level will be actively looking for opportunities to improve Asset Health Index ratings, and increase network reliability.

Moving from proactive to predictive
Asset Management practices should utilize AHI's for each major asset type as an integral building block to performing portfolio wide asset scenario analysis. Organization wide strategic planning AND operational planning activities will leverage the health indexes to provide a holistic view of which assets need attention, and where work and budget should be allocated.

Engineering knowledge will be implicitly included through the usage of Asset Health Indices and other supporting analysis which has been enabled by engineering inspections and analysis.

Keep in mind, Asset Management will involve several other sources of input beyond just AHI's.

Return on investment discussions

Making the decision to implement Asset Health Indices is a significant move for any organization. The discussions leading to such a decision can also be characterized along the maturity model. The following arguments and counter arguments for Asset Health Indices were obtained from the interviews of utility companies in this whitepaper.

Reactive

Of the Canadian utility companies interviewed, several aligned to the reactive level of the maturity model. These companies provided similar reasons for not developing Asset Health Indices, citing the prohibitive cost of the data collection and ROI calculations that did not demonstrate a clear benefit. In one example, a company hired a third party to perform condition assessment testing on an asset class in an effort to predict future failures. While the data quality was excellent, it was determined that the cost of doing the testing and analysis was higher than if the company simply repaired the assets upon failure. In fact, the overall number of assets was too small to make the testing and analysis worthwhile from a cost perspective[8].

Controlled

The business case and ROI calculations for generating large amounts of data can be varied, but one utility at the controlled stage demonstrated that collection and analysis of asset data enables better long-term maintenance planning and reduced costs. This is achieved through a more accurate understanding of the assets, and reducing overtime and rushed work orders. The utility observed savings of up to 20% on their O&M costs as a result of better planning. When combined over multiple asset types in an asset management framework, these savings can become very significant.

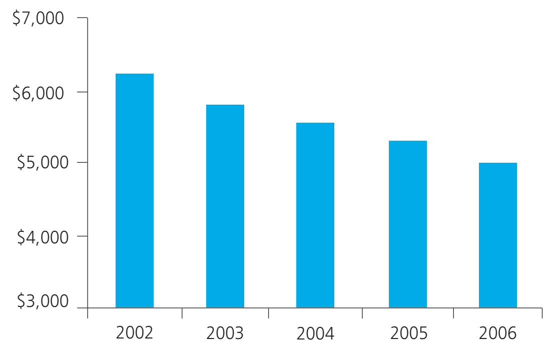
Proactive

The biggest cost at this level of the maturity scale is data collection, followed by asset analytics.

One ROI argument used by a Canadian utility to support advanced analytics was that better understanding of assets led to more accurate financial control of the assets, including amortization rates. By utilizing more accurate end-of-life calculations, it was able to adjust amortization rates of wood poles to achieve a net savings of about $10 million per year[9].

Another example shows that an increased focus on asset health and reliability helped a utility decrease its breakdown maintenance costs by 21% or approximately $1.3 million per year over a six-year period. The graph below shows breakdown maintenance costs from 2002 to 2006, and is broadly reflective of the improving effectiveness of maintenance practices[10].

Breakdown maintenance cost 2002-2006 (000s)



Another Utility was able to increase funding for cable maintenance from $2M/year in 2012 to $13M/year in 2013. This increase was approved by the regulator because detailed Asset Health Index data was available to justify the added expense (source confidential).

Predictive

Several different business cases can be used to justify the significant amount of effort required to get to the predictive level.

Perhaps the greatest benefit of reaching this level of AHI maturity is the ability to feed asset management processes with reliable, consistent, and trusted asset information. This enables an organization to make fact-based decisions (provided other asset management inputs are included), leading to optimized maintenance practices and improved network reliability.[11]

In addition, optimizing data collection efforts and minimizing the amount of time field crews spend collecting data, saves significant time and money, freeing workers to focus on value-add activities.

[8, 9, 10] Source Confidential

[11] By focusing on activities aligned to reducing risk and improving asset health, overall network reliability increases while costs decrease.

Summary

Along with growing demand for better asset management practices, Asset Health Indices are growing in usage and sophistication. Among Canadian utility companies, there are clear distinctions between the more advanced Asset Health Indices some companies employ, and the very basic or minimal versions other companies are developing. The reasons are varied, but some common factors are:

- Regulator requirements are pushing some utilities to develop their Asset Health Indices quicker than they otherwise would have.
- Solid ROI arguments have been difficult for many utilities to define. Although the benefits typically exist, they are only revealed once the risk-centred maintenance programs are put in place.
- Company size and scale greatly affects its ability to employ advanced analytics and Asset Health Indices. With some exceptions, the most advanced utility companies are the largest ones with the most customers.

A few key success factors have emerged from this study.

Success factors

Dedicated asset management staff
One of the biggest factors for successful implementation of AHIs has been the existence of at least one dedicated asset management role within the organization. Due to its high level of complexity and requirement for significant engagement with various stakeholders across the enterprise, part-time resources simply do not have the capacity to be effective.

Committed leadership
There needs to be clear support and direction from senior leadership to drive asset management practices, and Asset Health Indices. These processes touch across many different service areas and groups within an organization that historically may not have interacted regularly. Overcoming the natural hesitations between these groups requires senior support.

Clear communications
AHI processes and tools are only as good as the people making them, and the data supplying them. To gain support (and increase quality of data) an organization needs to clearly communicate the purpose of asset management and the role each data element plays in the broader planning process. If this is clearly communicated, and employees are involved in the process, they will typically provide more support to the effort.

Collaboration with the regulator
Some organizations specifically mentioned strong regulator communications as being key to their success. Even if asset management processes are not strong, open dialogue creates trust and has been demonstrated to lead to greater budgetary success.

Understanding of Maintenance and Reliability Impacts
Many organizations have realized that performing predictive and/or proactive maintenance on their assets is beneficial. Aside from being cheaper (reduced overtime pay), planning asset replacements ahead of time allows for optimization of the assets. For example, system reliability might be improved by changing the transformer model in a certain location. If replacement is performed upon failure however, crews will need to simply switch out the transformer with the same model to bring the customers back online. If this same work was planned in advance, a new concrete pad could be created to fit the improved transformer model.

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