APPA FACILITIES INFORMATICS MATURITY MATRIX TECHNICAL REPORT

Abstract

Facilities Informatics is the intersection of facilities, information technology and management practices to achieve better facilities/operations. Facilities Informatics involves the application of information technology to facilitate the creation and subsequent use of facilities related data, information and knowledge. This Technical Report helps to characterize the nature of Facilities Informatics and the process on which an organization improves and matures its ability to gather, understand and apply data in decision making.

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Disclaimer

The concepts and guidelines presented in this publication are intended to assist facilities managers in the efficient and effective operation of their institutions. These are guidelines only and are not necessarily industry standards. Opinions expressed in this book are those of the authors and do not necessarily reflect the opinions of APPA. Mention of companies and products are for informational purposes only and are not intended by the publisher as an endorsement of any kind.

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Background

This Technical Report helps to characterize the nature of Facilities Informatics and the process on which an organization improves and matures its ability to gather, understand and apply data in decision making. In August 2015, following first discussions at the April 2015 APPA Thought Leaders symposium[1], a Work Group (under the auspices of the APPA Standards and Codes Council) was launched to study and develop a potential standard for Facilities Informatics. This is a first product of that Work Group, which anticipates further products as work continues.

<u>What is Informatics?</u>

This is a key question. One way of defining this is that "[t]he term 'informatics' broadly describes the study and practice of creating, storing, finding, manipulating and sharing information." Several definitions can be applied, and the working definition that the Work Group has used for this comes from the following understanding:

> "The discipline of Informatics makes connections between the work people do and technology that can support that work. It combines aspects of software engineering, human-computer interaction, decision theory, organizational behavior, and information technology."[1]

Thus, informatics is not merely information management it is information management that puts information into action. In the context of facilities, this looks to take facilities information and put it to work.

<u>Facilities Informatics, Defined</u>

What then do we mean by *Facilities* Informatics? Facilities Informatics is the intersection of facilities, information technology, and management practices to achieve better facilities operations and an improved built environment. Facilities Informatics involves the application of information technology to facilitate the creation and subsequent use of facilities-related data, information, and knowledge. Facilities Informatics enables and supports efficient and effective facilities services.

Some examples of facilities informatics applications include the design, development, implementation, maintenance, and evaluation of:

- communication protocols for the secure transmission of facilities data,
- electronic facilities record systems (regionally, provincially, territorially, or nationally),
- evidence-based decision support systems,
- classification systems using standardized terminology and coding,
- work management systems,
- facilities monitoring systems (e.g., computer controlled BAS/EMS systems),
- digital imaging and image processing systems,
- geospatial systems,
- telework and mobile technologies to facilitate and support remote diagnosis and treatment,
- Internet technology for engaging customers,
- methodologies and applications for data analysis, management, and mining,
- facilities information data warehouses and reporting systems,
- business, financial, support, and logistics systems,

[1] 2015 Thought Leaders Series, *Facilities & Technology: The Transformation of "Campus"*

- and more[2].

Beyond design, development, implementation, maintenance and evaluation, facilities informatics spurs action that enables constantly improving operations. To conceptualize the power of facilities informatics, it might be helpful to see how informatics is being used in another sector: healthcare.

Get Healthy: The Medical Informatics Example

How many times have you written the same information on a form for your doctor? Ideally, the number has gone down lately. That can be tracked to the way that the medical field has embraced informatics as a way to organize and understand patient data. By keeping track of medical information electronically, physicians are automatically given insights on how a patient's condition changes over time, what changes might be related, and when a cluster of patients covered by different physicians may be occurring, allowing far greater insight during the diagnostic phase. This integration continues throughout the care process, including having the informatics system provide information on potential treatments, automate pharmacy requests, and facilitate effective and constant communication between the patient and physician. At the same time, this data allows upper management to better understand the workflow of their hospital or office, plan for predictable, not-readily noticed patterns in patients, and react more quickly to situations that are trending out of normal bounds.

Beyond the positive effects that informatics can have for operators and managers, the medical field is unique in that informatics are mandated by many nations for recordkeeping. This also means that many aspects of informatics now are well defined, especially in regard to questions of data storage and exchange.

Getting from Where You Are to Where You Want to Be

Categorizing Your Information

Separate from this effort, the APPA Informatics Work Group established a Data Team to help understand the systems and locations from which various points of data originate. Numerous systems produce and rely on data. Whether from the CMMS, the EMS/BAS or from human resource management systems (e.g., PeopleSoft), the Data team is working diligently to understand and categorize data and data sets.

Common Nomenclature

A key task for the Data Team is to develop a manner to collect this data and to enable systems to cross talk. Similar to the effort of major producers of mechanical controls systems several years ago in creating BACnet, the Data Team is looking to figure out how best to develop a common nomenclature or framework to manage data across disparate systems.

Maturing Over Time: Data, Information, Knowledge, Wisdom

As data is collected, categorized, automated, and used, the data needs and facilities informatics processes will mature. Initially, as data is gathered it will be derived from limited fields. For instance, electrical metering initially may provide energy usage over time (kWh) and instantaneous energy magnitude/power (kW). But for an organization to get the most out of its data, it must work to mature this data by enhancing the fields taken

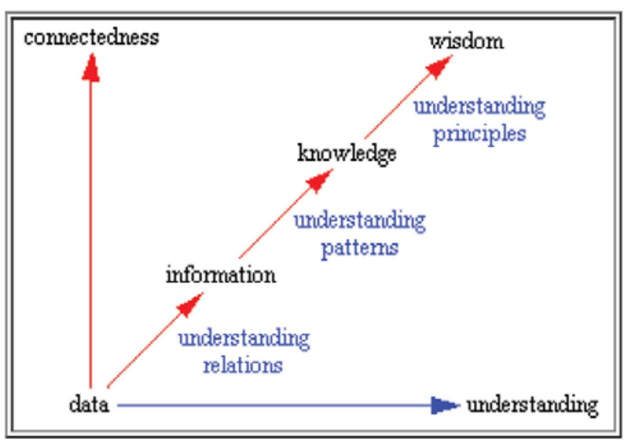
[2]University of Washington, Information School, What is Informatics? https://ischool.uw.edu/academics/informatics/what-is-informatics, accessed on 20 December 2015

(perhaps by metering usage at certain points) or providing more indepth views of the data being collected (i.e., adding data collection of minimum and maximum values, multiple collection of various data points to hedge against error, etc.). By growing the data set and maturing the data in those sets, one can gain more understanding. Additionally, as data matures, the risk associated in using the data collected is mitigated and the veracity of the information gleaned can be confirmed.

The D-I-K-W Construct

The Data, Information, Knowledge, and Wisdom (D-I-K-W, or DIKW) construct is one that has garnered much interest in the world of knowledge management and informatics[3]. This construct is a method by which the human mind, and organizations, take inputs in the form of data and take action on it by using principles that have been developed. The basis of this construct is data. Data, as described above is at its core are bare facts or statements that stand on their own. From this point, information is gleaned when one set of data is related to other data. This information can be good, or it could be bad, depending on the comparisons, and the patterns that are revealed. It is in the recognition and application of the use of patterns (e.g. best fits to a distribution) that enable the development of data driven knowledge. Once knowledge is developed, and patterns become regular to the point of being predictive or regular, principles develop that become part of an organization's wisdom.

The goal of facilities informatics is to develop wisdom from data that best inform facilities decision making processes, whether they be energy related, maintenance related, or capital program related and beyond. Good data does not guarantee that an organization will develop great wisdom, but it is a necessary first step for an organization to evolve and mature to that end. Likewise, the ability to relate data (information) and see patterns (knowledge) is something that has to be developed over time. The goal is to develop an organizations informatics capacity and capability to the point that its decision making is both highly connected as well as having a high level of understanding. Using a maturity matrix model enables institutional tracking of this process.

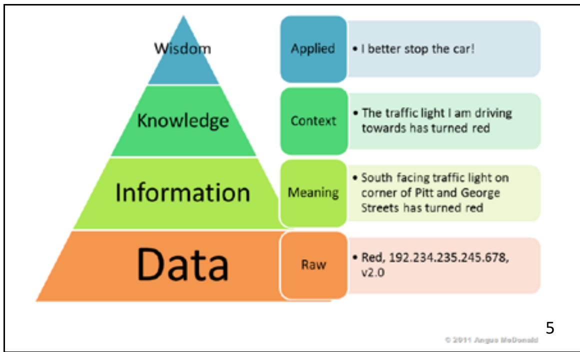


[4]

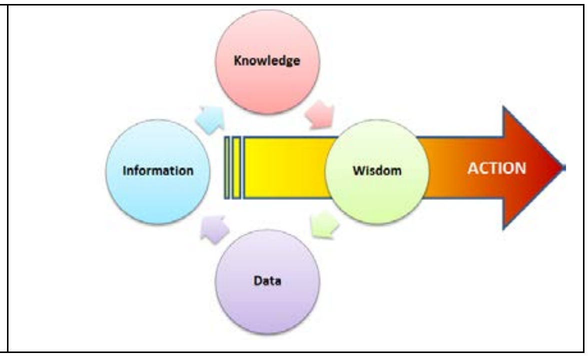
The D-I-K-W Construct Relating it to Connectedness and Understanding

As each field in the D-I-K-W construct matures, there is a feedback mechanism that enables each of the preceding to become more robust, or to discover additional domains that can and should part of the informatics of a facilities organization. So as an organization's informatics matures, wisdom helps to inform the data that ought to be collected to begin more and more cycles.

[3] Bellinger, Gene; Castro, Durval; Mills, Anthony; Data, Information, Knowledge, and Wisdom, 2004, http://www.systemsthinking.org/dikw/dikw.htm, accessed on 16 October 2015
[4] Ibid.



D-I-K-W Pyramid



The D-I-K-W Cycle

The Facilities Informatics Maturity Matrix

Learning from Other Maturity Matrix Models

Data Maturity Models (DMM) follow a well-defined order of definitions to describe how data is being managed and used. Having been implemented in organizations specializing in medical care, finance, and information technology, DMM has proven vital to improving the effectiveness of operational groups. Across issues of data expectations, structure, information policies, quality protocols, governance, standards, technology, and performance management, there is a clear roadmap to develop a fitting model to describe how data is being managed in any field. In facilities management, there is potential to utilize DMM to improve the responsiveness of facilities operations, maintenance planning, and service evaluation, and to estimate the value-add of physical plant projects.

A great resource for understanding DMM is David Loshin's book *The Practitioner's Guide to Data Quality Improvement*[6]. There are eight evaluation areas defined by Loshin in this text. Focusing on both IT operational requirements and business processes, he evaluates data quality expectations, dimensions, information policies, protocols, governance, standards, technologies, and performance management on levels going from Initial to Repeatable, Defined, Managed, and finally Optimized. Expectations, dimensions, information policies, protocols, standards, and technology all can be categorized as IT-led directives with a focus on data warehousing, software engineering, and format standards, while governance and performance management are best thought of as business process issues, which are focused on redesigning service and management operations.

While at the **Initial** maturity level, common processes are non-existent, and individual processes are unshared. Issues are addressed as they emerge, based on severity, and the environment is generally unstable. Beyond this is the **Repeatable** level, where simple good practices and effective methods have been codified into a basic form of organizational management and information sharing. At the **Defined** level, processes are well documented and shared, providing consistent use. There is a structure for organizational governance of data, with buy-in from business groups and IT. At the **Managed** maturity level, data management planning incorporates impact analyses and performance assessment criteria to develop a weighted measure of service effectiveness, more effective than the preceding simple managerial analysis. Finally, at the **Optimized** level, data management is an enterprise-level policy, allowing widespread analysis of performance. At the optimized stage, facilities

[5] Fernandes, Louis; "The Journey from Data to Knowledge and Wisdom," 22 July 2014, https://www.linkedin.com/pulse/20140722053326-3033591-the-journey-from-data-to-knowledge-and-wisdom, accessed on 6 June 2016

[6] Loshin, David, *The Practitioner's Guide to Data Quality Improvement*, 29 October 2010, Morgan Kaufmann Publisher

organizations, for instance, move from reactive use of informatics to a proactive use, enabling process improvement, cost savings/avoidance, and predictive maintenance and facilities development.

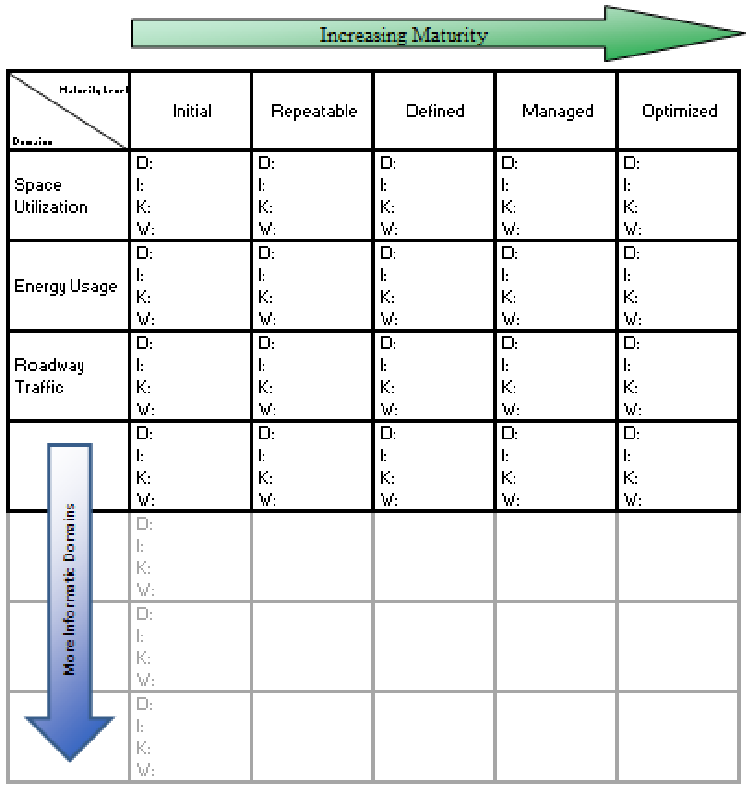
These levels can be applied to each of the areas described in the framework. In the case of the standards area applied to facilities management, the various levels may be characterized as follows:

- Initial
  - No set data standards
- Repeatable
  - Defined formatting of data at the storage level
  - Common service measures and facilities operations mapped to standardized data elements
- Defined
  - All facilities operations mapped to a defined data structure
  - Schemas for data exchange defined
- Managed
  - Trusted input systems (e.g., service requests, project planning) certified to use defined data structures
  - Ongoing maintenance to ensure all new projects are tied-in to data system
  - Oversight to ensure standards are followed and kept up-to-date
- Optimized
  - Standards defined using common, industry-set, taxonomy
  - All systems providing data (service requests, inventory, receiving, etc.) are compliant with data standards, as a policy
  - Proactive use of informatics to facilitate improved outcomes

Developing the Facilities Maturity Matrix Construct

Using the D-I-K-W model in conjunction with the Levels of Maturity discussed above, a matrix emerges where facilities organizations can measure and understand their informatics maturity, across all of the domains of each organization.

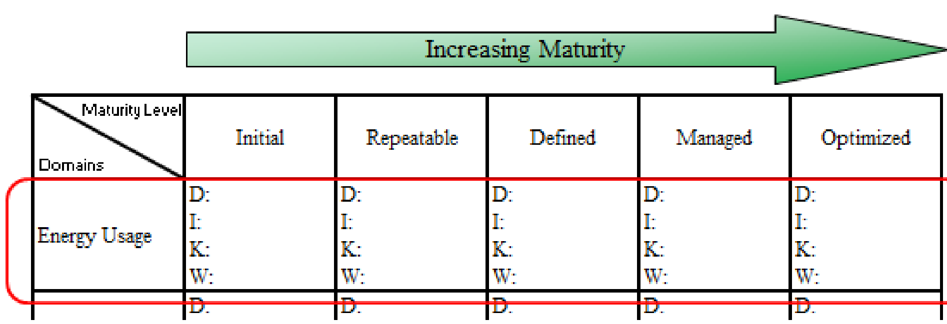
The Facilities Informatics Maturity Matrix plots the various domains of a facility organization along the Y axis, and the levels of maturity along the X axis to form a matrix field. Within each field cell, a set of criteria, related directly to the particular facilities domain, is articulated for Data, Information, Knowledge, and Wisdom. These criteria allow an organization to measure how well they are performing in that particular domain, across the D-I-K-W model as its informatics matures.



Facilities Informatics Maturity Matrix Framework Illustration

<u>Illustration: Matrix Maturity for Energy Usage</u>

As an example, one Domain of Facilities Informatics is clearly Energy Usage. This could certainly be broken into sub-domains (e.g., electrical energy, gas energy, etc. or precinct X energy, precinct Y energy, etc.), but for illustration purposes, and because it is common to nearly any organization, this paper will simply look at energy usage.



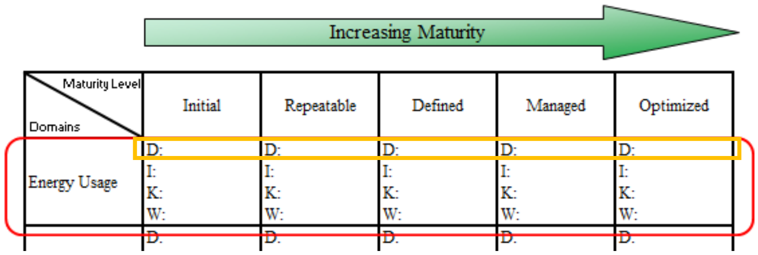
Energy Usage Maturity Matrix

In order to determine the level of maturity in this area, clear criteria have to be developed for how each domain area is scored for its Data, Information, Knowledge, and Wisdom. For Energy Usage, this may be a completely different set of criteria as compared with custodial services, for instance.

For illustration purposes, we will provide expected practices throughout the Energy Usage domain. Because it is common to be "drowning in data," while gaining little in the way of Knowledge or Wisdom, an organization may not be at the same level of maturity in each of the dimensions of Data, Information, Knowledge, and Wisdom.

For this reason, we will discuss maturity levels in the context of the separate D-I-K-W areas. Also of note is that while, in general, maturity is limited by the preceding area (with Wisdom at a lower maturity than Knowledge, which is lower than Information, which is lower than Data), this is not always the case, and rarely holds beyond the Defined level of maturity. A final consideration is that as the state-of-the-art improves, the criteria for an Optimized system changes. In general, the properties of an Optimized organization are the best conditions that can be imagined *at this time*. This concept can be seen in the example practices below.

Data Maturities

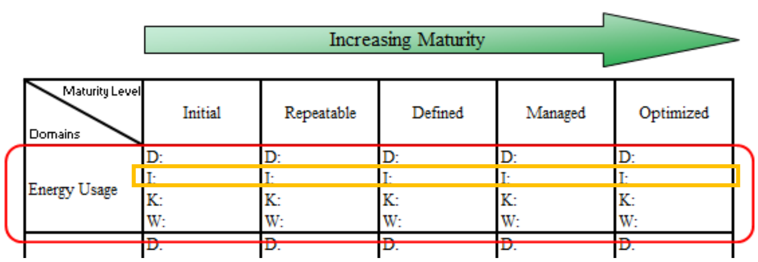


Initial: Usage data taken manually, at random
Repeatable: Usage data taken manually, on regular basis
Defined: Energy performance analysis performed as part of maintenance
Managed: Energy usage data recorded automatically by building management tools
Optimized: Performance analysis performed automatically as data is recorded

Energy Usage, Data Maturity Level Practices

Data maturity in Energy Usage is relatively simple to judge, and can generally be graded on levels of automation, from no automation at Initial, to full automation at Managed. Optimized is reserved for state-of-the-art practices. In the case of Energy Usage, as it stands Optimized data would consist of automated comparisons between building energy model simulations and recorded usage. In theory, Optimized maturity could also include sub-second resolution on consumption metering, which, while outlandish at this time, may become standard practice as technology improves.

Information Maturities

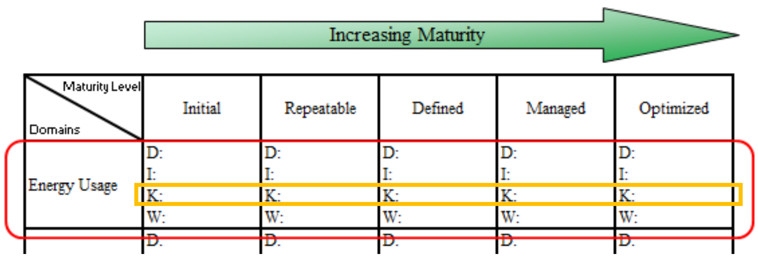


Initial: Generalized average consumptions calculable
Repeatable: Periodic average consumptions calculable
Defined: Up-to-date building energy performance available
Managed: Usage data is available in visualized form
Optimized: Comparative visualizations provide multiple reference points for energy usage

Energy Usage, Information Maturity Level Practices

At lower levels, Energy Usage Information Maturity is forced to lag behind, or at best match, Data Maturity. This is clear due to the fact that, for instance, up-to-date building performance cannot be determined if the only consumption data available consists of a single reading from the previous quarter. Until clean, consistent data is available, visualization of any form is impossible. Even then, visualizations, and especially comparative visualizations, will be limited by data availability.

Knowledge Maturities

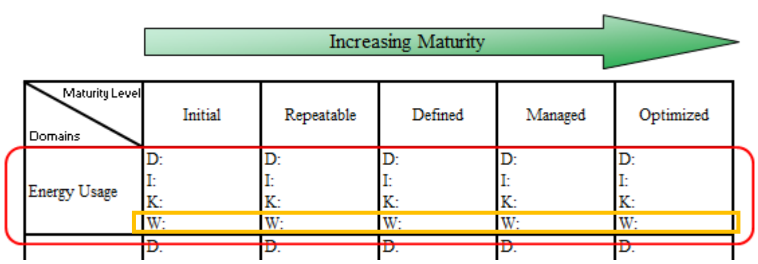


Initial: Aware of approximate year-to-year changes
Repeatable: Aware of year-over-year and continuous period-to-period changes
Defined: Performance metrics available for project and maintenance planning
Managed: Energy monitoring system recommends action when highly divergent usage seen
Optimized: Automatic work orders generated

Energy Usage, Knowledge Maturity Level Practices

Knowledge Maturity in Energy Usage will also be limited by Data Maturity. Much like in the case of Information Maturity, consistent data is required to achieve anything beyond a Repeatable maturity for Knowledge. However, Knowledge is able to develop beyond information with effective use and analysis of data outside of a managed work-stream. Automation in an organization with high Knowledge maturity allows effective and responsive operations, without requiring a high Information maturity. In essence, it is not necessarily required to have detailed information about energy consumption to act on an automatically generated ticket saying a piece of equipment requires attention, which is the ultimate goal of Optimized Knowledge.

Wisdom Maturities



Initial: Able to forecast approximate energy costs for budgeting
Repeatable: Improved forecasts account for one-off events, peak periods
Defined: Higher confidence ROI available for project planning decisions
Managed: Decision making and project planning integrates university objectives
Optimized: Future use predictions can accurately integrate planned growth, due to explicit correlation between multiple factors and use in models

Energy Usage, Wisdom Maturity Level Practices

Energy Usage Wisdom maturity is dependent on more factors than the preceding maturities, and deals with extra-procedural and extra-departmental issues. After enough data is available to perform simple budgeting projections, Managed Wisdom requires an awareness of university objectives in the near and long-term, along with non-traditional resources. This can include a push for integration with academic projects, or supporting research work. Optimized Wisdom is achieved when highly accurate energy models, developed with massive amounts of data, are used in conjunction with university plans and projections to create highly accurate future energy use projections.

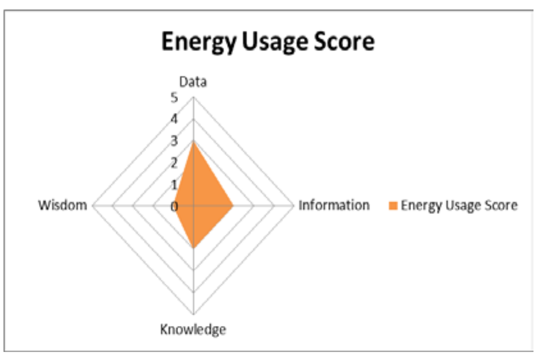
After all criteria are defined for each level of a Domain, the model can be used to classify different operations and processes related to the Domain.

<u>Example Processes and Visualizations/Classifications</u>

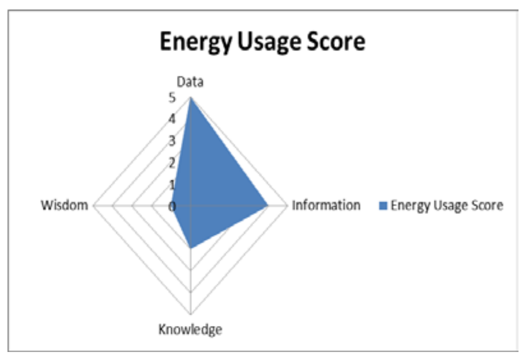
How electricians tend to wire breakers : Repeatable Knowledge
Electricity purchasing options : Managed Knowledge
Secondary impacts on electricity purchasing choice : Managed Wisdom
Large and vital mechanical systems sub-metered : Optimized Data
Cooling system determined to need earlier-than-expected maintenance, due to excessively rising electricity consumption : Optimized Knowledge

Energy Usage, Example Hybrid D-I-K-W-Maturity Case Evaluations

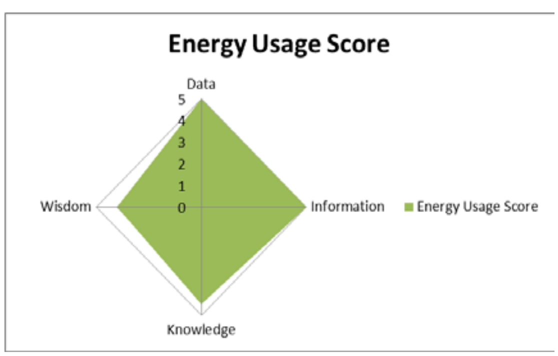
The future work of the Informatics Work Group and APPA as a whole will help to flesh out criteria across a range of domains for facilities organizations. Once fully developed, this matrix will enable organizations to understand how they are performing in terms of their informatics across their entire enterprise, with an objective of improving maturity. By simply applying a value of one (1) to Initial through five (5) for Optimized maturity, one can quickly plot a radar chart to determine the overall level of maturity that exists in the organization for a particular informatics domain. The following charts illustrate growing maturity in the area of Energy Usage, for instance:



Fairly Immature Organization



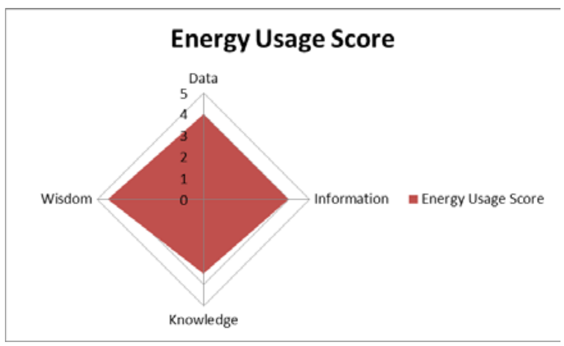
A Maturing Organization



A Mature Organization Data Maturity Usage: UT Austin Example

The University of Texas (UT) at Austin has seen substantial positive impact from establishing an informatics-focused facilities operations plan. The decision-making process at the university now relies on a data stream which integrates work order trends, EUI and energy efficiency data, mechanical systems conditions, age, and replacement value, building conditions, research dollars, and risk management data. The last category, risk management, focuses on what impact the requirement has on the university. The evaluation includes how long will the building be down if an issue is not addressed, and what kind of area will be affected.

There are two matters for consideration in the information provided here. First, there is the matter of UT Austin's "risk management data." In the context of the framework, the analysis involved in the development of said data would instead fall in the Knowledge or Wisdom dimensions of the D-I-K-W model, rather than the Data dimension. This can also be said for research funding data. The other matter is that it is possible to give a rough estimate of UT Austin's Energy Usage informatics maturity, as a minor case study. Their overall Energy Usage Maturity likely resembles the following radar graph. Some factors of note are that the Knowledge dimension is scored near Defined, since it appears that there is no automated data analysis system, and that the Wisdom dimension is scored almost at Optimized, in light of how often factors outside of the facilities department itself are used in planning.



Estimated Maturity, Energy Usage, UT Austin

The team at UT Austin reports that this integration of informatics has caused multiple improvements for the facilities department. The project began to develop a data driven program for recapitalization and renewal for facility systems on campus. The primary improvement is that project planning and prioritization has become far more effective, thanks to a well-defined and followed decision-making process. This leads to three, vital secondary improvements; departmental culture and morale has improved as operations show appreciable progress and impact, alignment with university objectives has improved by integrating said objectives into planning, and budgeting has improved as sound projects are easily defended in consideration of the planning process. UT Austin now receives $22 million for deferred maintenance a year, far more than the $8 million received five years ago.

Maturity Matrix Application Case Studies

The next step in the development of this maturity model is to testbed the concepts by applying it to case studies across the spectrum of college/university facilities and beyond. In drafting this paper, we have not yet executed this phase, but hope to in the coming year.

Conclusions/Future Work

This maturity matrix can help to guide organizations in how they collect, manage, and use data for better facilities outcomes. When institutions develop increasing data maturity, they move from reactive operations to proactive results.

The Facilities Informatics Work Group envisions that, through APPA and its membership, the Facilities Informatics Maturity Matrix can be broadened across numerous additional domains and become a tool used throughout our member institutions. As a result, one of the future efforts of the Work Group is develop a live input model that enables key subject matter experts across our member institutions to develop the maturity model for a particular domain in the matrix.

Additionally, this Technical Report is the first of several products and deliverables that will come out of the efforts of the Work Group. APPA members and others outside of APPA should be on the look-out for those products as they are released.

Acknowledgments and Contacts

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- The Facilities Informatics Work Group of the APPA Standards and Codes Council
- APPA - Leadership in Educational Facilities

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