(#ID-TBC) Project Analytics for the 21st Century

Arrow, JAMES – FRICS DRMP

Economists predict that the Fourth Industrial Revolution is set to cause fundamental disruption. Within the Engineering and Construction sector, a proliferation of data streams promises to provide new levels of diagnostic and predictive insight, both increasing efficiency and improving the likelihood of successful project delivery. However, the construction and engineering sector is notoriously slow to adopt new technology. Professionals in our industry must actively work to raise their levels of digital maturity if they are to maintain a competitive edge. During this presentation, we shall explore how AI can drive digital disruption including the skills and knowledge AACE International members should develop so they may exploit Total Cost Management Analytics.

Speaker's Bio

- Project Management professional and Chartered Quantity Surveyor with more than 20 years of experience
- Broad range of Industrial / Commercial Engineering, Procurement, and Construction (EPC) experience working with Fortune 500 contractors and Owner organizations
- Market sectors include oil and gas, aerospace, mining, power generation, government operations, pharma and IT Program Management
- Recent experiences include the development of Risk Management capability improvement plans, the deployment of state-of-the-art risk analysis solutions including the development of network-enabled asset tracking platforms designed to enhance construction productivity planning and control on large capital projects
- Currently providing Project Risk Management consulting services for Mozambique LNG

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ALGO QUE NO SABEN DE MI: My interest in diving (sky & scuba) helped kick-start my interest in Risk Management.


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AGENDA
• Industry 4.0 & Digital Disruption
• New & Emerging Construction Technologies
• Technology Advancements Relevant to Project Professionals:
The Path Towards Total Cost Management Analytics (TCMA)
• Developing Statistical & Data Literacy within our Profession
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Industry 4.0 &
Digital Disruption
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A Brief History of Industrial Progress

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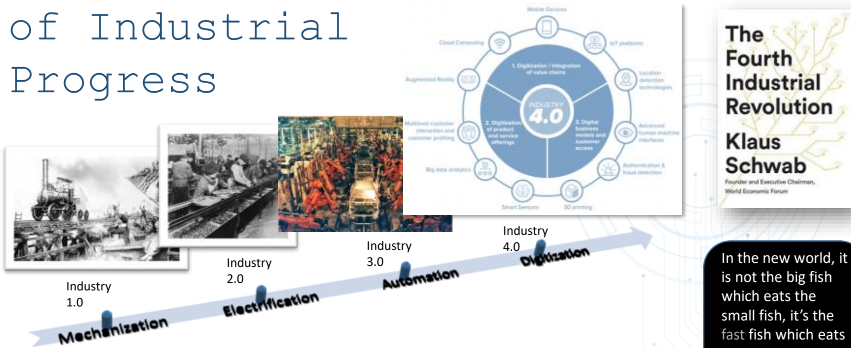

In the new world, it is not the big fish which eats the small fish, it's the fast fish which eats the slow fish

Klaus Schwab
Founder and Executive Chairman
World Economic Forum

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Modified from https://i1.wp.com/www.ictworks.org/wp-content/uploads/2019/03/fourth-industry.png?resize=640%2C367&ssl=1

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Digital Dominance

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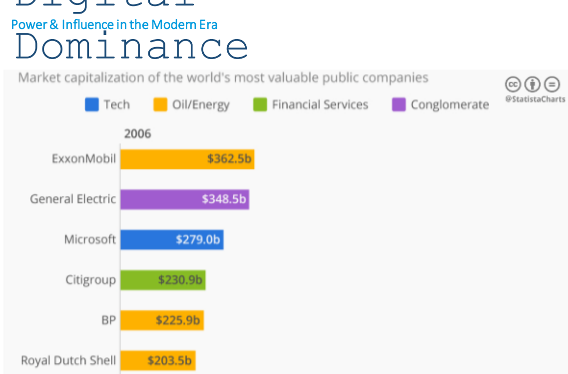

Ten years ago, Amazon was working hard to become more than an online bookstore, Facebook was three years old and the iPhone was only a few months old.

Now, there's no ignoring the growing significance of technology.

Source: https://www.statista.com/chart/5403/most-valuable-companies-2006-vs-2016/

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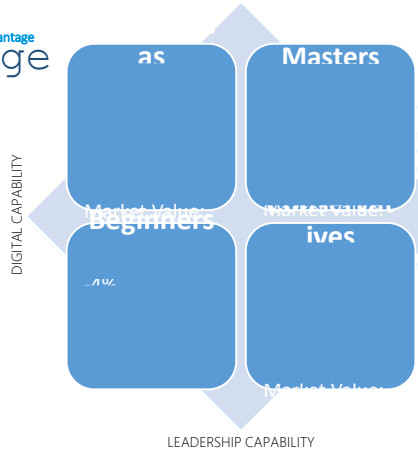
Digital Advantage

Technology driving economic advantage



www.aacei.org.pe Source: Capgemini 2013, Digital Transformation, Beyond the Hype https://www.slideshare.net/capgemini/digital-transformation-beyond-the-hype

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New & Emerging *Construction Technologies*

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ConTech Trailblazers

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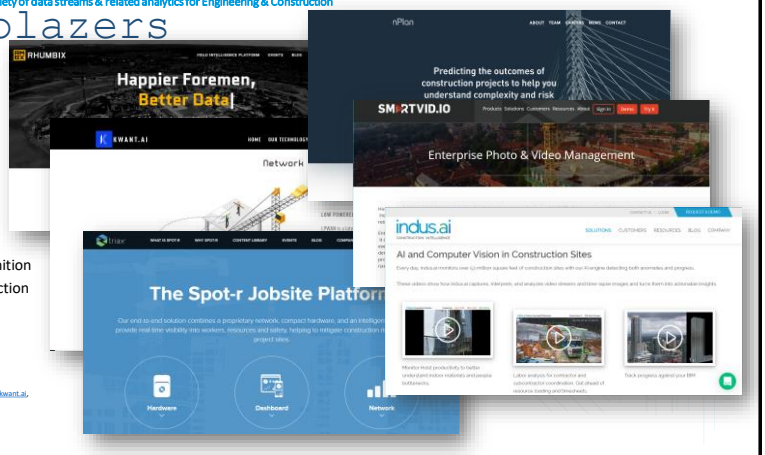
Increasing access to a wide-variety of data streams & related analytics for Engineering & Construction

- Asset Tagging
  - Plant
  - Materials
  - Personnel
- Imaging
  - Visual
  - Video
  - Lidar
- Machine Learning
  - Image recognition
  - Hazard prediction
  - Schedule optimization



Source: https://www.rhumbix.com/, https://www.kwant.ai, https://www.triaxtec.com, https://www.nplan.io/, https://www.smartvid.io, https://www.indus.ai,

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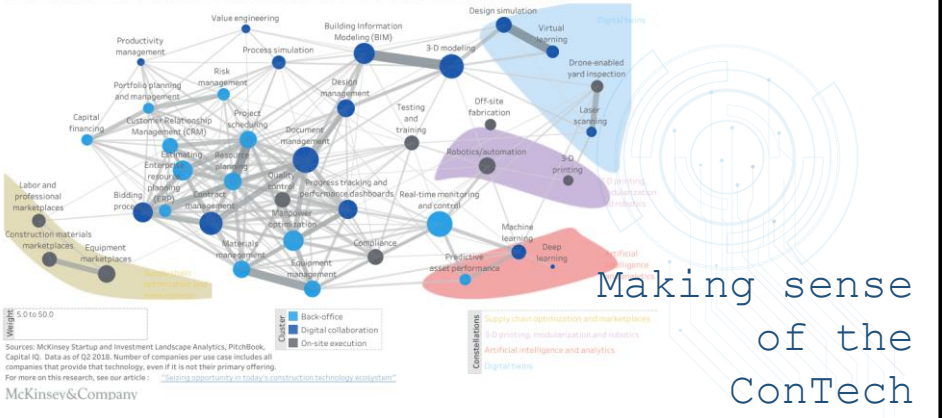
Mapping the construction technology ecosystem

McKinsey analyzed the growing construction technology landscape to look for trends and constellations of activity around established and emerging use cases. Thicker lines connecting two use cases indicate a greater number of technology companies offering both technologies simultaneously.

Click on a use case/technology to view its related solutions. Use the zoom options and weight slider to explore the relationships between different technologies. To isolate technologies by functional cluster or constellation, click to highlight or select the option to filter. Zoom / unfilter by clicking the same option again or the white space.



Sources: McKinsey Startup and Investment Landscape Analytics, PitchBook, Capital IQ. Data as of Q2 2018. Number of companies per use case includes all companies that provide that technology, even if it is not their primary offering. For more on this research, see our article: "Seizing opportunity in today's construction technology ecosystem"

McKinsey&Company

Making sense of the ConTech Ecosystem

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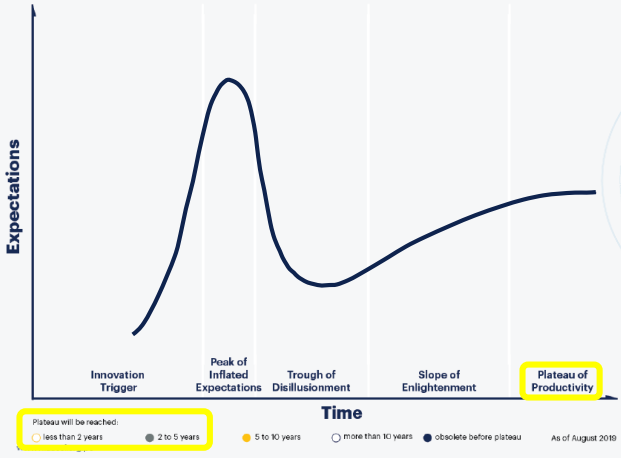
Gartner Hype Cycle for Emerging Technologies, 2019



- **Cutting through the AI hype;** within 2 to 5 years, computer vision, IoT platforms and advanced analytics will have an increasing impact upon our profession

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The Path Towards *Total Cost Management Analytics*

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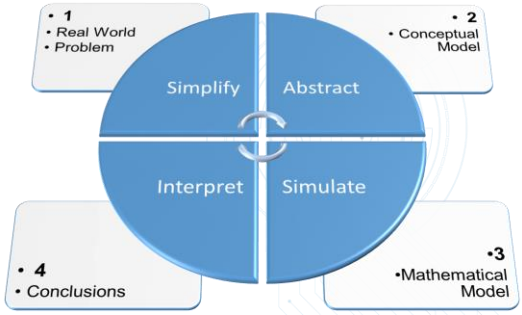
Mathematical Modeling for Project Control

"*A mathematical model is a description of a system using mathematical concepts and language.*

A model may ***help to explain a system and to study the effects of different components, and to make predictions about behavior.***"

http://en.wikipedia.org/wiki/Mathematical_model



Adapted from: *The Mathematical Modeling Cycle*, http://www.indiana.edu/~hmathmod/modelmodel.html

Playing with Prediction

Building the case for "Big Data"

- The Law of Large Numbers
  - *the more a game is played, the better mathematical probability predicts the outcome*
- **We don't know exactly what will happen but, with the right data, the likelihood of future events can be calculated**
  - *Since we have been able to better understand probability, there have been huge advances in science.*

Gerolamo Cardano

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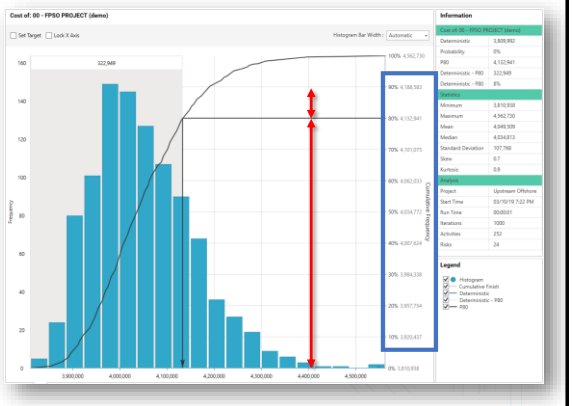
Typical QRA Output

The conventional CRA (Cost Risk Analysis) Distribution Curve

- **Contingency** will depend on the company's or project's required Confidence Level or **Risk Appetite** (sometimes set at P50, P70 or, for example, P80 as shown here).
- In some cases, a **Management Reserve** may be withheld at P90. The delta, from P80 to P90 in this example, is typically intended to account for uncertainty outside the team's control.



con·fi·dence in·ter·val
/ ˈkänfəd(ə)ns ˈin(t)ərvəl/
noun STATISTICS

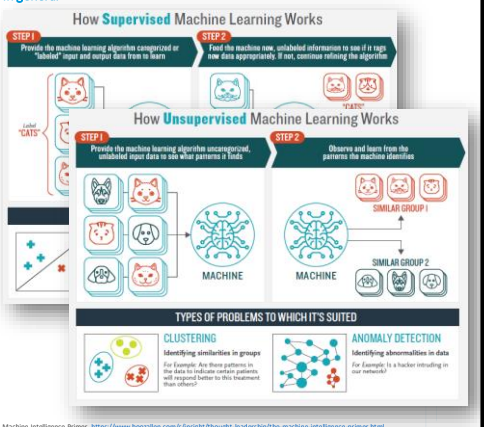
a range of values so defined that there is a specified probability that the value of a parameter lies within it.

At the 80% confidence interval, our project will cost between $3.9MM & $4.2MM or +3% to +10%.

Advanced Analytical Modules

The case for Secondary Modelling & employing Data Science methodologies in general

- No single model holds ***the answer*** to a question.
- Using the conventional, probabilistic analysis of project outcomes as a ***Primary Model,*** project professionals must embrace unconventional data streams and advanced analytical techniques to develop ***Secondary Modelling*** to:
  - **Corroborate** initial uncertainty ranging
  - **Validate** preliminary risk analysis results
  - **Predict** outcomes given current performance
  - **Optimize** outcomes with given current resources



Pouring relevant risk artifacts, **structured *and* unstructured**, into a Data Lake enables organizations to discover new connections and patterns.

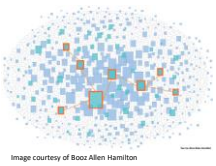
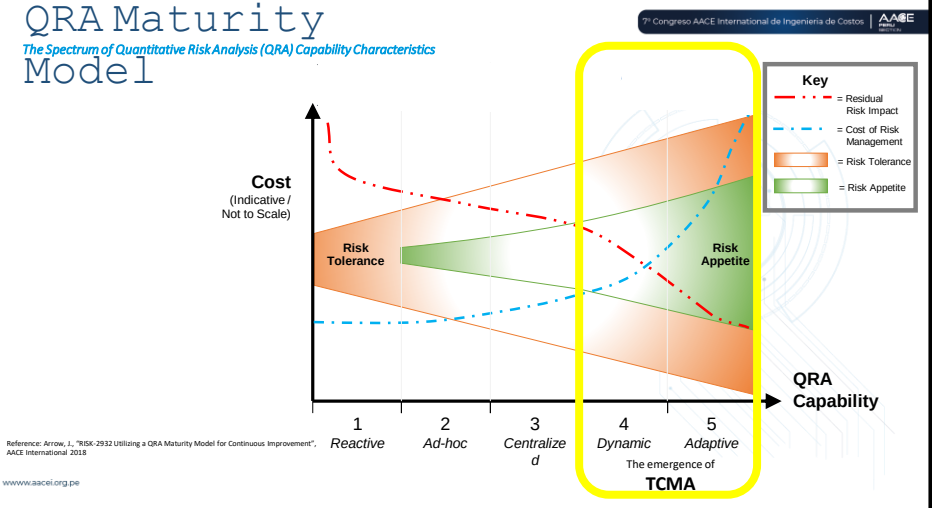


Image courtesy of Booz Allen Hamilton

Source: The Machine Intelligence Primer, https://www.boozallen.com/s/insight/thought-leadership/the-machine-intelligence-primer.html

QRA Maturity Model

The Spectrum of Quantitative Risk Analysis (QRA) Capability Characteristics



Reference: Arrow, J., "RISK-2932 Utilizing a QRA Maturity Model for Continuous Improvement", AACE International 2018

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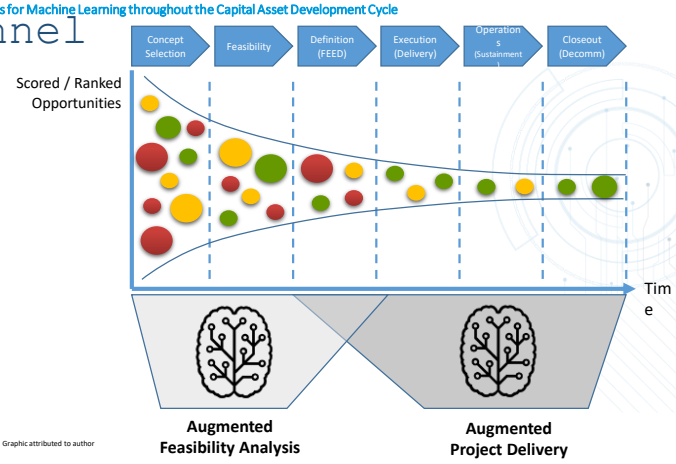
AI & the Investment Funnel

Opportunities for Machine Learning throughout the Capital Asset Development Cycle



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Augmented Project Delivery

Recognizing the importance of feedback mechanisms to improve predictability

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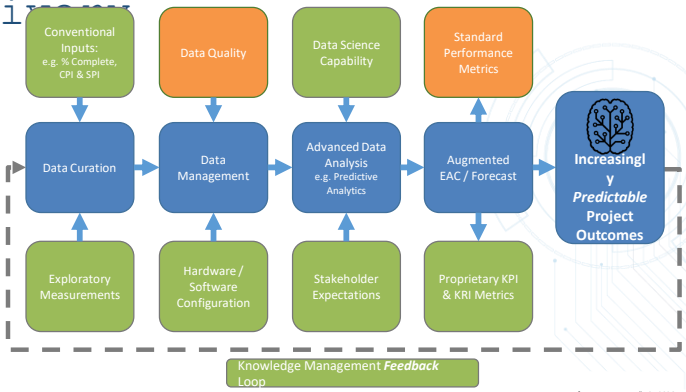

KEY: Primary or dependent variable | Driving forces | Area for research / industry collaboration

Reference: Arrow, J., "RISK-2926, Project Controls & Data Analytics in the era of Industry 4.0", AACE International 2018

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Total Cost Management Analytics (TCMA)

Optimizing the balance of People, Process & Technology

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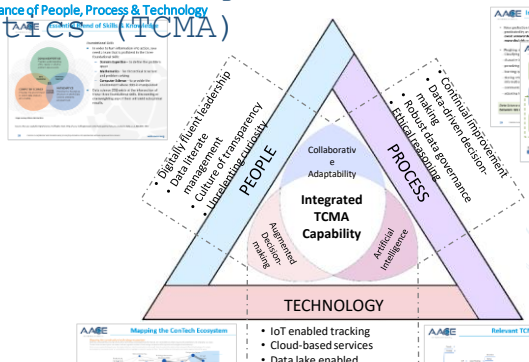
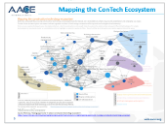
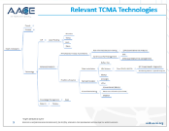


Partnership opportunities?
- RICS (ICMS)
- NIBS (COBie)
- CII
- IPA



- IoT enabled tracking
- Cloud-based services
- Data lake enabled discovery
- Embedded analytics



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Developing Statistical & *Data Literacy* within our Profession

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Skills & Knowledge Venn Diagram

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The enduring importance of the Domain Expert

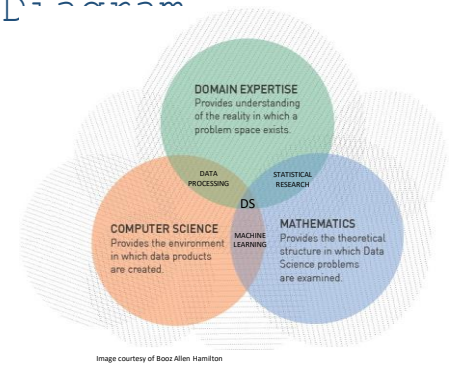

Image courtesy of Booz Allen Hamilton

Foundational Skills

- In order to turn information into action, you need a team that is proficient in the three foundational skills:
  - **Domain Expertise** – to define the problem space
  - **Mathematics** – for theoretical structure and problem solving
  - **Computer Science** – to provide the environment where data is manipulated
- Data science (DS) exists at the intersection of these three foundational skills. Discounting or overweighting any of them will yield suboptimal results.
- ***You***, as the Domain Expert, play a key role!

Source: Are you ready for Data Science, Huffington Post, http://www.huffingtonpost.com/shelly-palmer/are-you-ready-for-data-sc_b_6844032.html

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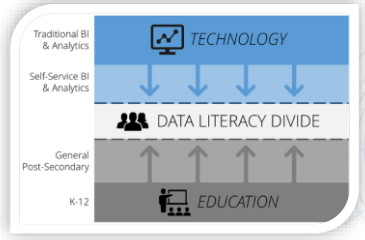
The Data Literacy Divide

An opportunity for AACE to help companies develop twenty-first century skills within our professional community

A certain elementary training in statistical method is becoming as necessary for everyone living in this world of today as reading and writing.

- H. G. Wells



4 Keys to **Minimum Viable Data Literacy**:

1. **Data knowledge**: Industry & discipline data terms & datasets
2. **Data assimilation**: consistent methods to interpret the unfamiliar
3. **Data interpretation**: employing the right approach to make a significant observation
4. **Data skepticism & curiosity**: awareness concerning quality, causation, significance & bias

"Data in the hands of a few data experts can be powerful, but data at the fingertips of many is what will be truly transformational."
– Brent Dykes, Sr Dir Data Strategy at Domo

More information about data literacy is available at: http://dataliteracy.info/

By Time Magazine - Time Magazine, Public Domain, https://commons.wikimedia.org/w/index.php?curid=73448010

Source: Why Companies Must Close The Data Literacy Divide, Forbes, https://www.forbes.com/sites/brentdykes/2017/03/09/why-companies-must-close-the-data-literacy-divide/#7572a202369d

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Summary

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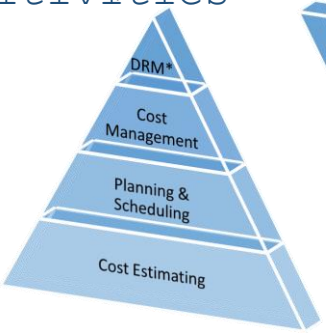
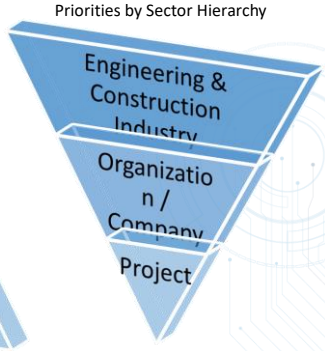
TCMA Priorities & Sensitivities

Priorities by TCM Area of Focus



Priorities by Sector Hierarchy

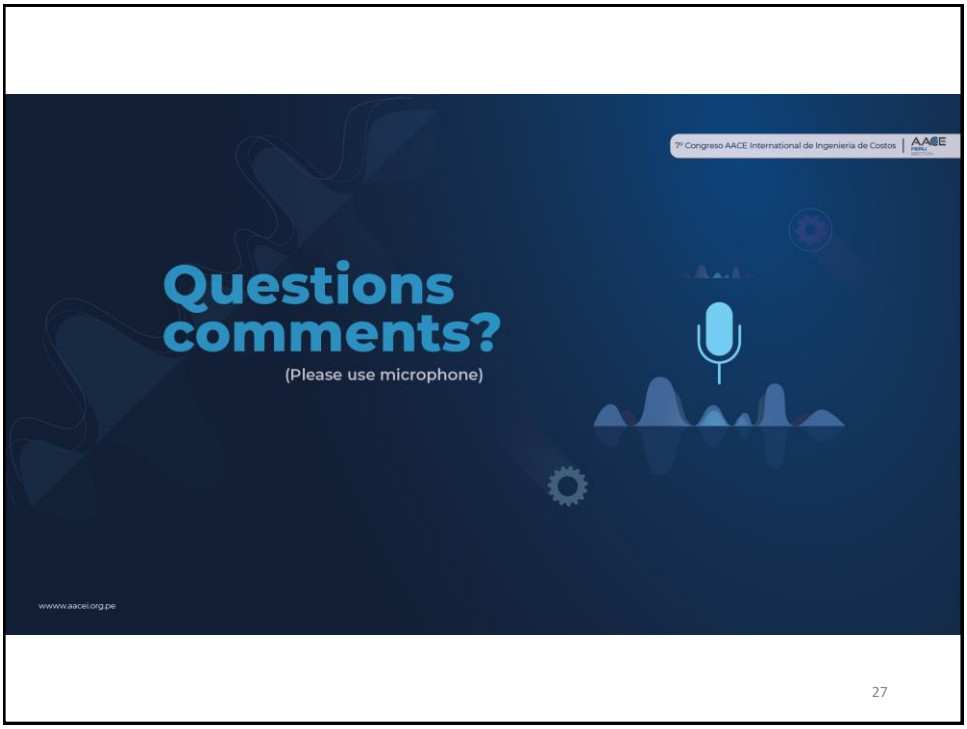


*NOTE 1: DRM = Decision & Risk Management
NOTE 2: Other levels / priorities to be addressed with subsequent development iterations.

Conclusion

The virtues of a Risk-based Kaizen philosophy

- Mathematical probability can help us better predict project outcome.
- Data is not someone else's job; **raising your level of *Data Literacy* is crucial** if we are to unlock the full potential of data in our industry.
- A continual improvement program can deliver TCMA and a *risk-based competitive advantage*.
- ***AI won't replace Project Professionals but Project Professionals who use AI will replace those who don't.***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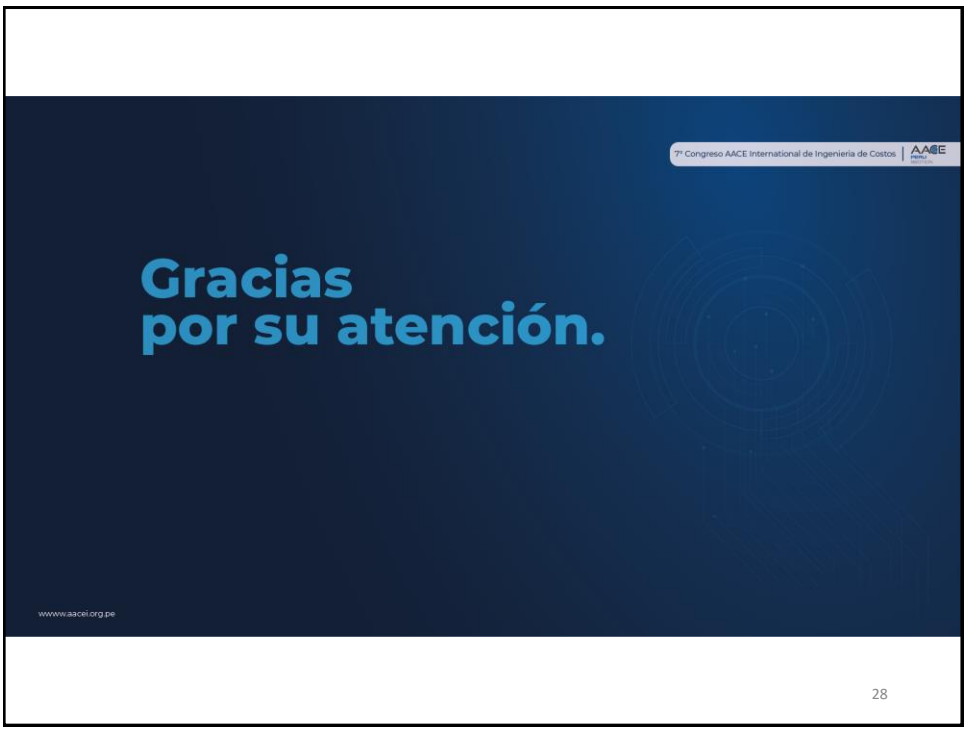
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