# کنترل پروژه پیشرفته و ارزیابی عملکرد در پروژه‌های پیچیده

**(بر اساس اسناد CII)**

فصل سوم:

معماری اطلاعات به‌صورت آنی در APC


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# What we will learn?

- Information Layers in APC and the Shift from Retrospective Reports
- Generation, Processing, and Interpretation of Real-Time Information
- Prioritization and Standardization of Real-Time Metrics
- Data Flow Enablement for Predictive Controls

# Information Layers in APC and the Shift from Retrospective Reports

# Information layers

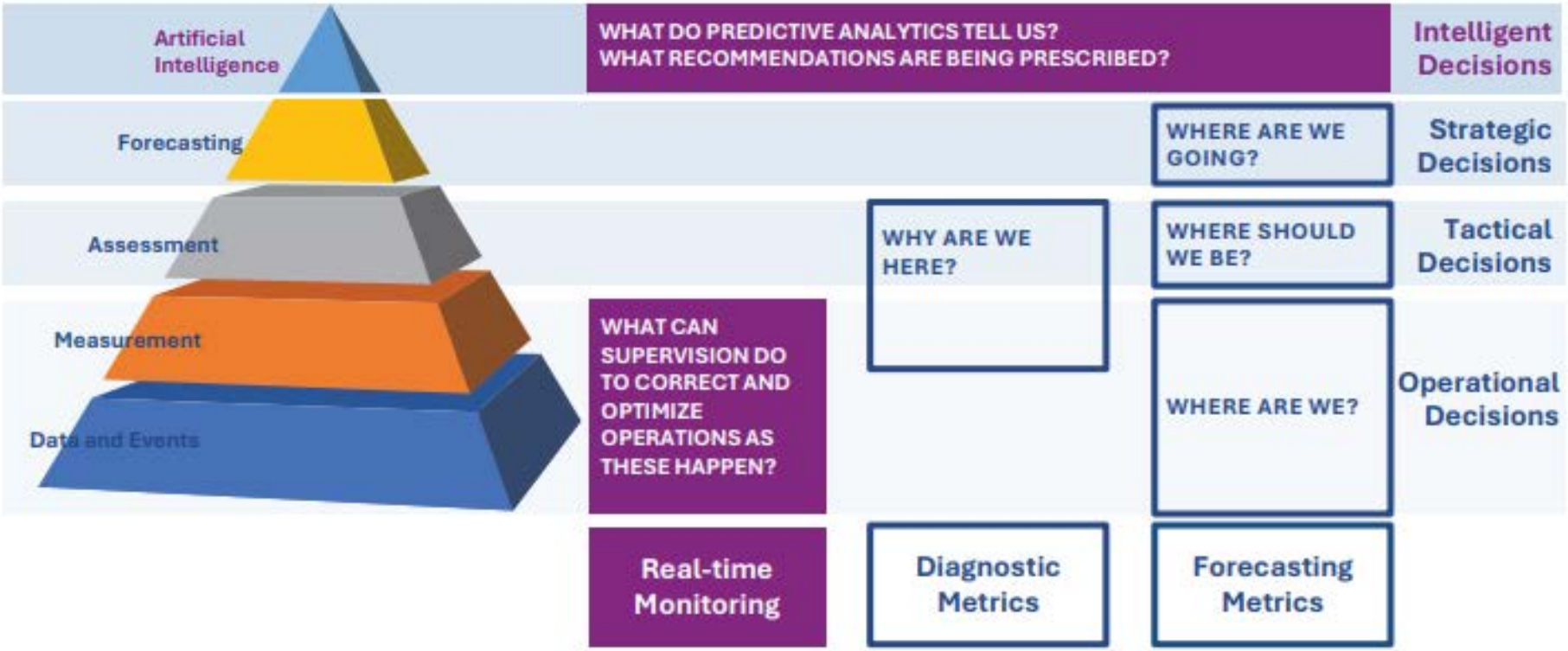


Figure 6. Information Layers

# Defining information layers

- The **definition** of each information layer follows.
  - **Data and events.**
    - ✓ The data and events layer represents the **foundation** of project controls, **capturing all** digital data and event notifications related to the project.
    - ✓ It provides structured and unstructured data, including metadata, and triggers **alerts** on issues and events.

      *Examples of data include design errors and omissions, new or delayed requests for information (RFIs), change order status updates, procurement and fabrication status and delays, alerts on delays affecting the look-ahead plan and installation work packages, updates on long-lead items, or absenteeism and turnover records.*

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# Defining information layers

- The definition of each information layer follows.
  - **Measurement.**
    - ✓ The measurement layer **facilitates** the in-depth evaluation and scrutiny of project and information **facets**.
    - ✓ Its **primary objective** is to ensure **good progress** by identifying and mitigating deviations, assessing emerging trends, issuing alerts as prescribed, or identifying root causes.

      *Examples include trends in safety, engineering errors and omissions, or delayed procurement orders by vendor or installation priorities. It also evaluates field production and productivity by analyzing factors such as time on tools, consumables use, or crew/trade/area productivity ratios and trends.*

# Defining information layers

- The definition of each information layer follows.
  - **Assessment.**
    - ✓ The **assessment layer** enables the comparison of performances against the established baseline, such as cost, schedule, quality, safety, or productivity. It **gauges** progress and **pinpoints** concerns.
    - ✓ **Assessments** can be applied to the entire project or partially, whether by phase, area, contractor, or discipline.

      *Examples of metrics include Earned Value (EV), Actual Cost (AC), CPI, or SPI.*

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# Defining information layers

- The definition of each information layer follows.
  - **Forecasting.**
    - ✓ The **forecasting layer** offers insights into the **anticipated performance** for the remainder of the project, either
      1. at completion or
      2. at any intermediate timeline, or
      3. by phase, area, discipline, or contractor and subcontractor.

      *Examples of metrics include Estimate to Completion (ETC), VAC, or EAC.*

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# Defining information layers

- The definition of each information layer follows.
  - **Intelligence.**
    - ✓ The intelligence layer leverages automated reasoning mechanisms to provide **intelligent observations**.
    - ✓ This layer allows for the **deployment** of analytics, including **statistical analysis** and benchmarking, as well as computation-driven reasoning methods, such as **AI** and **machine learning (ML)**.
    - ✓ While it **utilizes** project data from the **preceding layers**, it also **analyzes** information from **other sources**.

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# Defining information layers

- The definition of each information layer follows.
  - **Intelligence.**
    - ✓ Internal data sources should consist of datasets from **similar completed projects.**
    - ✓ External data sources incorporate information of potential interest to the project, such as commodity pricing trends, weather, labor market shifts, or currency exchanges.
    - ✓ This layer also offers the **capability** to extract structured data from unstructured sources (e.g., text documents, pictures, videos) with suitable algorithms.
    - ✓ Additionally, it offers the ability to **streamline** project controls tasks.

# Real-time information for improved project performance

- Building on the **hierarchy of information layers**, RT-402 explored the information items and metrics that when **updated in real-time** are poised to enhance project performance.
- Seamless **sharing** of data and information is an **inherent aspect** of APC.
- **Real-time data collection** coupled with **automated analytics** offers **timely insights** to **decision-makers**, who can make rapid and informed decisions.
  - **Not all** project controls data and information, however, will **benefit** from continuous or real-time updates.
- **While continuously updating** time-sensitive and critical information is **crucial**, **updating other** information and metrics **at regular intervals** can be **sufficient** to ensure that decisions remain informed and timely.

# Real-time information for improved project performance

- **Even though** the **continuous update** of the data and information has been regarded as a **paradigm shift** for construction organizations,

  knowing which information layers or metrics demand **real-time updates**

  will **reduce the need** to

  continuously collect across-the-board data and

  immediately generate the corresponding information.

# Real-time information for improved project performance

- The team used **10 pre-qualified SMEs** to participate in a **panel**.
- SMEs were asked to **quantify** the optimal frequency at which each information item or metric should be generated to **maximize its value**.
- **Consensus** on real-time as an optical frequency was achieved when **five or more** of the **panelists** agreed that a metric should be updated continuously or at least daily.
- **Four or five panelists** indicated a metric should be constantly or updated daily, a **near consensus.**

# Real-time information for improved project performance

- **Real-time prioritization** benefits data and information that,

  **if not immediately** conveyed, their **impact** is likely to **rapidly increase** with the passage of time.

  - Thus, the **inability to update** critical or near-critical paths in the schedule **threatens to delay** an entire project.
  - In **another example**, the **impact** of **design errors or omissions** on construction will probably **escalate**

    without the rapid communication of corresponding alerts.

# Real-time information for improved project performance

- Specifically, the **panel of experts** indicated the need for **real-time updates** on **45** of the team's original **168 operational metrics**.
  - **Consensus** was achieved for 29 metrics,
    while **near consensus** was met for 16.

- Regarding phases, **34 metrics** are associated with construction,
  **eight** with procurement, and **three** with engineering.
  See **Figure 7.**

*Appendix II contains the real-time information priorities.*

# Real-time information for improved project performance

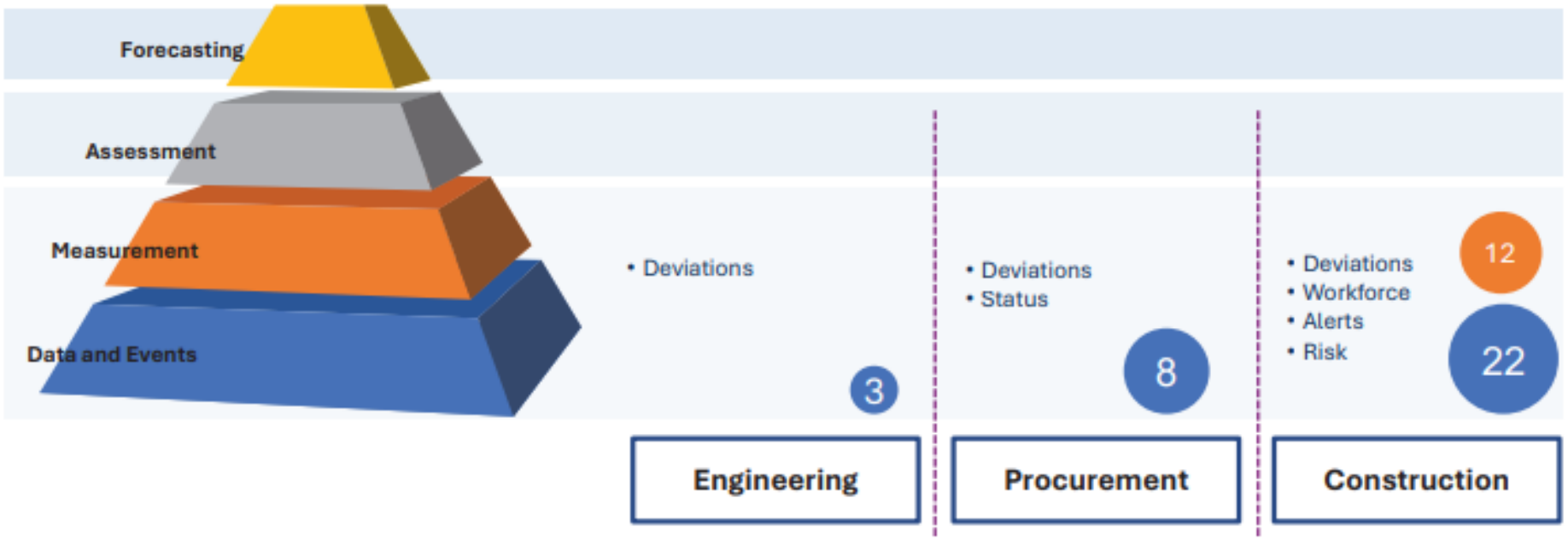


Figure 7. Prioritization of Real-Time Information

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# Leading information

- Notably, the assessment and forecasting layers do **not require real-time** updates.
  - The **daily variation** of assessment metrics like CPI is **negligible**.
  - Experts expressed that it is **nice** to have but **not a must.**

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# Leading information

- The team evaluated the **potential of each** information layer to provide **leading clues** to supervisors, project managers, and corporate managers.

- Results indicate that **differences exist** in the **ability** of the distinct layers to offer clues to each role.

  See **Figure 8**.

# Leading information

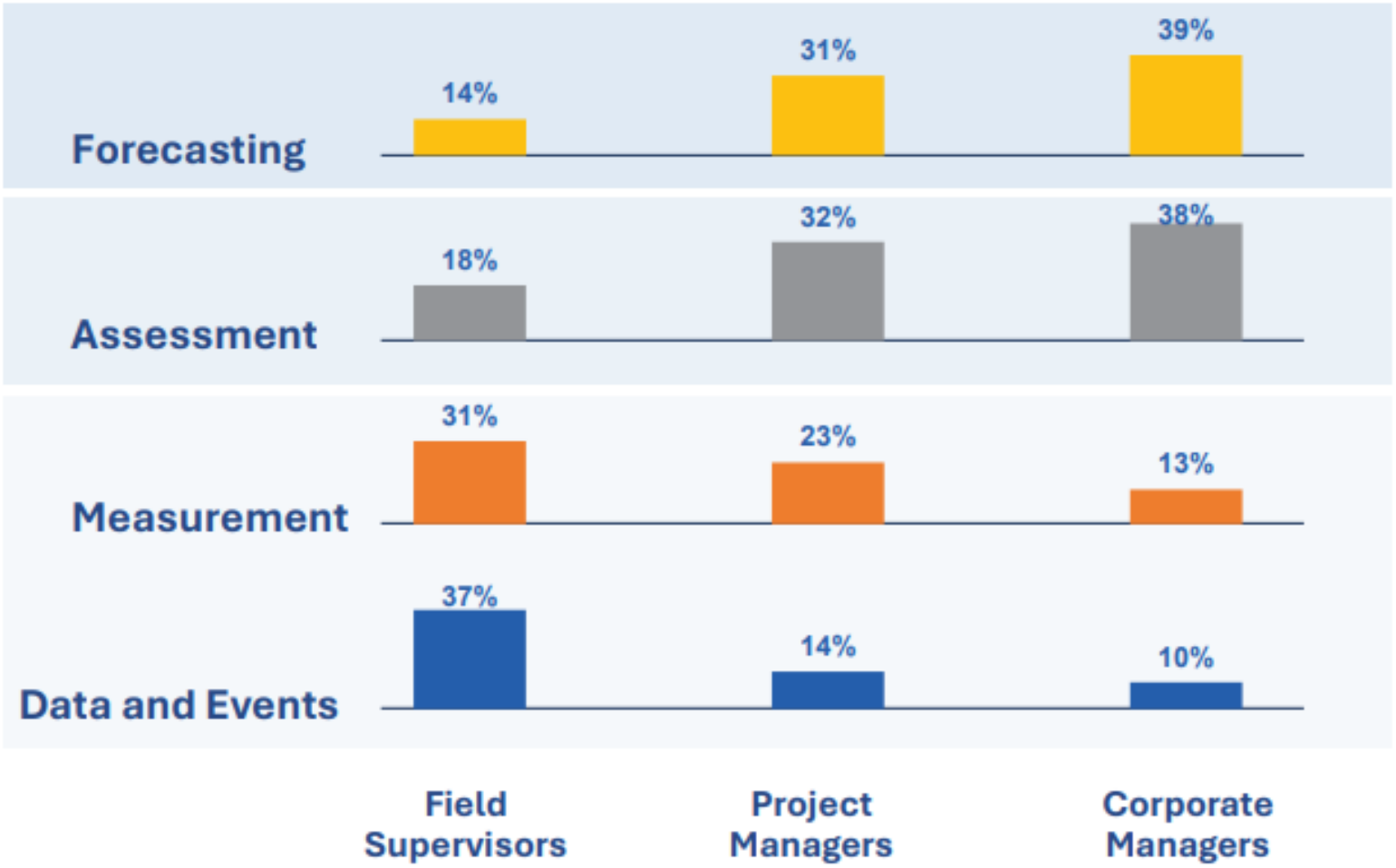


Figure 8. Leading Information

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# Leading information

- **Supervisors** primarily **rely on** the data and events and the measurement layers, the information that supports **daily operations**.

- On the contrary, **project managers**, and even more pronounced, **corporate managers** **rely** predominantly on the assessment and forecasting layers.

Such differences are **consistent** with the **purpose of each role**.

# Generation, Processing, and Interpretation of Real-Time Information

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# Streamlining project controls processes

- APC offers the opportunity to streamline the execution of project control tasks and processes in real-time.
- This **Section** explores **prioritizing** project controls processes for
  automated and
  real-time
  execution, which can help align information with **execution efficiency**.
- The **focus** is on **processes** inherent to project controls:
  1. data collection,
  2. risk management,
  3. quality management,
  4. schedule updating, and
  5. reporting.

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# Streamlining project controls processes

- **During three workshops**, the SMEs discussed prioritizing processes with RT-402.
- In **each workshop**, SMEs were first requested to **list** and **rank** the processes that would most improve project performance in real-time.
- They **then** were asked to **list** and **rank** the most time-consuming processes.
- The following sections **detail the results**.

# Real-time value

- **Responses** from the SMEs were first consolidated into **17 processes** for **opportunistic** improvement with real-time. See **Table 4**.

Table 4. Opportunities for Real-Time Controls (n=24)

| Rank | Process | SME Agreement (%) |
|---|---|---|
| 1 | Progress Monitoring | 79% |
| 2 | Cost Management | 71% |
| 3 | Schedule Management | 58% |
| 4 | Reporting | 46% |
| 5 | Data Management | 42% |
| 6 | Risk Management | 38% |
| 7 | Planning | 29% |
| 8 | Change Management | 25% |
| 9 | Forecasting | 21% |
| 10 | invoicing | 13% |
| 11 | Material Management | 8% |
| 12 | Procurement | 8% |
| 13 | Administrative | 4% |
| 14 | Analysis for Reporting | 4% |
| 15 | Quality Management | 4% |
| 16 | Scope Management | 4% |
| 17 | Benchmarking | 4% |

# Real-time value

- The **five processes** that are the **most highly beneficial** to project performance when continuously updated are
  1. progress monitoring,
  2. cost management,
  3. schedule management,
  4. reporting, and
  5. data management.

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# Real-time value

- **Progress monitoring** was considered the **most valuable process** when executed in real-time,

  **while** both cost and schedule updating can influence **decision making immediately.**

- **Reporting** is also key to timely and informed decision-making, and

  thus, it is regarded as **another influencer** of performance when reports can be **generated on-demand**.

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# Automation potential

- The research team then consolidated SMEs' responses into **17 tedious and time-consuming processes**. See **Table 5.**

Table 5. Automation Opportunities (n=38)

| Rank | Process | SME Agreement (%) |
|---|---|---|
| 1 | Schedule Management | 100% |
| 2 | Data Management | 89% |
| 3 | Reporting | 49% |
| 4 | Progress Monitoring | 47% |
| 5 | Administrative | 30% |
| 6 | Cost Management | 26% |
| 7 | Change Management | 19% |
| 8 | Forecasting | 19% |
| 9 | Planning | 17% |
| 10 | Analysis for Reporting | 15% |
| 11 | Material Management | 13% |
| 12 | Procurement | 11% |
| 13 | Risk Management | 9% |
| 14 | invoicing | 9% |
| 15 | Quality Management | 6% |
| 16 | Scope Management | 4% |
| 17 | Benchmarking | 2% |

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# Automation potential

- The **five processes** benefitting the most from automation are
  1. schedule management,
  2. data management,
  3. reporting,
  4. progress monitoring, and
  5. administrative tasks.
     - Thus, the **results identify** the project control processes that **liberate practitioners' time** and **resources** the most.

These **five processes** should be **prioritized** to guide automation efforts.

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# Real-time automation

- When **combining** real-time and automation potential,

  the results identified the following **most beneficial** processes:

  1. progress monitoring,
  2. cost management,
  3. schedule management,
  4. data management, and
  5. reporting.

  See Figure 9.

# Real-time automation

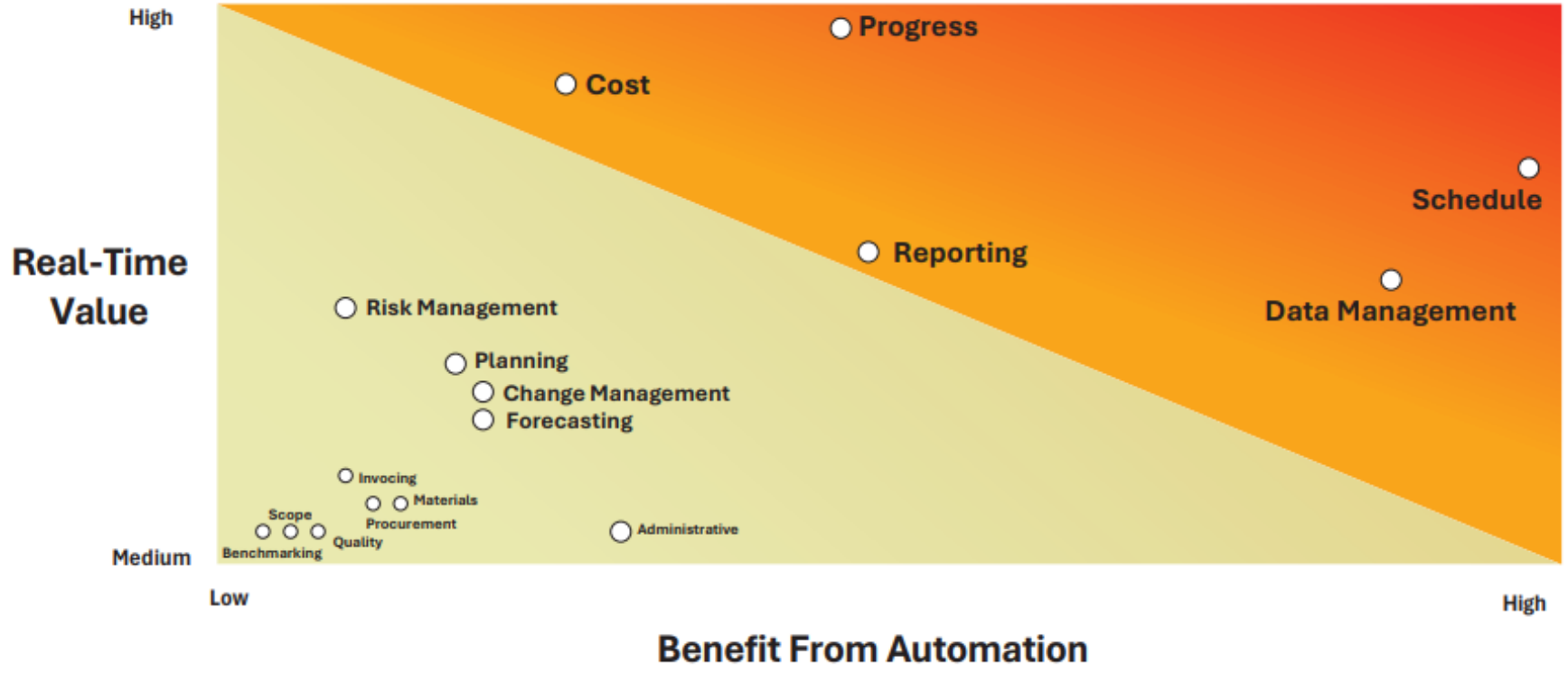


Figure 9. Prioritization of Real-Time Automation

- SMEs observed these processes as having the greatest potential for **real-time automation**, thus bringing the ability to **highly influence project performance** with real-time updates, **liberating** notable project team **resources**.

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# Real-time automation

- **Not all the processes** listed in Table 4 and Table 5 could be considered in the analysis of **real-time automation**.
- A **one-to-one relationship** between the processes in the above sections did **not always exist**

  since real-time value and automation are **two different aspects**, which resulted in **specific tasks** or **processes** being listed only once.

  - Thus, a **limitation** exists here.
- The **three preceding** sections on real-time value, automation, and real-time automation should be **considered together**.

# Prioritization and Standardization of Real-Time Metrics

# Appendix 1

- Project Controls Metrics and Information

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# Appendix 2

- Prioritization of Real-Time Information

# Data Flow Enablement for Predictive Controls

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# Technology domains

- During its research and focusing again on **streamlining** APC processes,

  **RT-402** characterized **30 prominent** sensing and information technologies,

  all with the **potential to streamline** project controls.

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# Technology domains

- **Computing technologies** applied to controls focus on the data analysis and generation of information, including **extracting information** from datasets such as videos, texts, or images.
- To **facilitate analysis and comprehension**, the team **grouped existing technologies** into seven technology domains:
  1. Mobile computing
  2. Wearables
  3. Visualization
  4. Automation and robotics
  5. Tracking and tracing
  6. Augmented reality (AR) and virtual reality (VR)
  7. AI.

# Technology domains

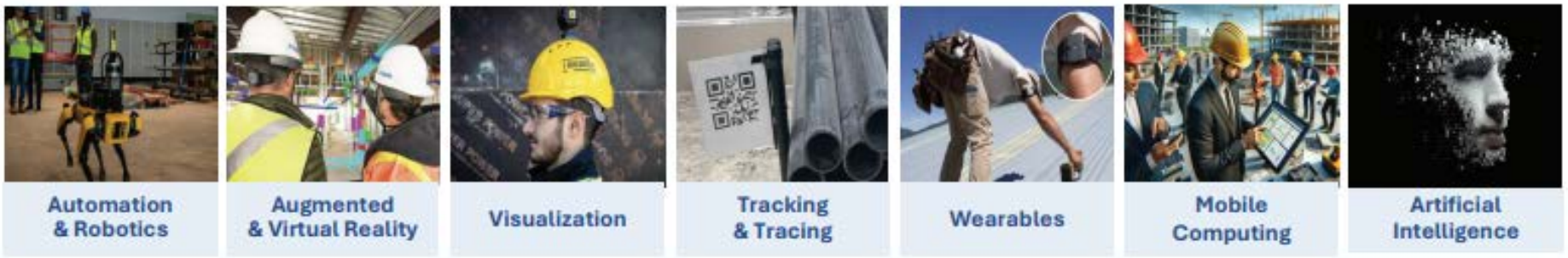


Figure 10. Technology domains

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# Technology domain groups

**You will see the comprehensive checklist + analysis**

**of this part**

**in the last section of this course**

# موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)


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