کنترل پروژه پیشرفته و ارزیابی عملکرد در پروژه‌های پیچیده
(بر اساس اسناد CII)

فصل چهارم:
تحلیل عملکرد سیستم کنترل پروژه با ابزار خودارزیابی (PCMS Self-Diagnostic)

ارائه دهنده:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

CMAA Authorized Trainer

دانشگاه Illinois Tech آمریکا

What we will learn?

- PCMS Self Diagnostic Assessment Tool
- Assessment of the Seven Key PCMS Functions: Estimating, Planning, Scheduling, Cost Control, Change Management, Progressing, and Forecasting

PCMS Self Diagnostic Assessment Tool

PCMS self diagnostic assessment tool

- **RT 244** identified a range of practice in **project controls** and **management systems implementation**.
- An **initial survey** of CII members revealed broad variance in self-reported performance along **seven different PCMS functions**
  1. estimating,
  2. planning,
  3. scheduling,
  4. change management,
  5. cost control,
  6. progressing, and
  7. forecasting in

  the **dimensions** of systems, tools, and training.

PCMS self diagnostic assessment tool

- While **some differences** were noted between owner and contractor member companies,

  overall findings suggest that there is **industry-wide room** for improvement in each of the **seven PCMS functions.**

PCMS self diagnostic assessment tool

- Building on their experience, the research team members developed a **set of questions** for each of the PCMS functions.

- Wording and relevance of the questions were **validated** with project controls **professionals at companies** not directly involved in RT 244.

PCMS self diagnostic assessment tool

- **Each question** is designed to reveal areas of implementation weakness and is intended to be a leading indicator to help focus on **specific items**.
- **No differences** exist between **questions** for contractors or owners.
- Each question has a **yes or no answer**.
  - If yes, the assessment is positive.
  - If no, the question should reveal an action item for remedies.

PCMS self diagnostic assessment tool

- The set of questions was **not designed** to give an **overall score** for PCMS implementation –

  RT 244 felt that **such scores** are too general and that organizations should prioritize action items from an assessment based on **corporate circumstances**.

- **Appendix A** contains the PCMS Functions Self-Diagnostic Assessment Tool, which details definitions for each of the **seven PCMS functions** as well as **diagnostic questions** related to implementation **details for each function**.

PCMS self diagnostic assessment tool

- **Deployment** and **follow-up** is straightforward.
- **Individuals** in each member company with **thorough-going knowledge** of the each **specific PCMS function** should **answer the questions** for that function.
  - As the set of **seven functions** often **cross traditional boundaries** (e.g., planning and scheduling may be separate from estimating),

    it is likely that **several persons** will need to be **involved in the assessment.**
- Companies that **split project controls responsibilities** across business units may wish to focus the tool and assessment within a **specific business unit**.

PCMS self diagnostic assessment tool

- **After answering** the questions, **"No" responses** should be reviewed and action items generated.

- Each individual respondent should **generate an initial set** of action items and recommendations.
- **Overall responses** should be collected by senior leaders, refined, and prioritized.

- Recommendations and actions developed from the self-diagnostic questions can stand on their own or be combined with

  advice and **remedies** generated from other tools developed by RT 244, including those detailed in the **next section of this publication**.

PCMS self diagnostic assessment tool

- It is important to note that the **questions for each PCMS** function are meant to
  1. reveal common areas of weakness and
  2. hence opportunity for improvement;

     few if any organizations will **answer yes to all questions**.

     - An **honest assessment** is necessary for improvement.

Assessment of the Seven Key PCMS Functions: Estimating, Planning, Scheduling, Cost Control, Change Management, Progressing, and Forecasting

Appendix A

- **One of the major findings** of Research Team 244 is that the tr**aditional PCMS principles** are **still valid.**
  - However, the survey research shows that the **fundamentals of PCMS** are often either not implemented or implemented ineffectively by companies.
  - The following Self-Assessment questionnaires are designed to **help an organization assess its practices** for each of the PCMS functions.

Appendix A

- The following slide provides a definition of PCMS and definitions of each of the **seven PCMS functions**.
- The questions are formatted to correspond with the research team's recommendations for developing an effective PCMS program.
  1. If the answers to most questions are **yes**, the PCMS program conforms to the recommendations.
  2. If the answer to a question is **no**, the question statement can be used as an action item to improve it.

Appendix A

- The self diagnostic assessments were designed for both **owner** and **contractor** organizations.

1. The research team understands that **owner organizations** may choose to **rely on** the **contractor** to perform certain **PCMS functions**.
   - If that is the case, the **questions** should be applied to the **project team.**

2. This resource could also be used as a tool for an **owner to evaluate** a **contractor's PCMS capabilities.**

Appendix A

- Included in this Appendix are:
  1. Definitions of 7 PCMS Functions
  2. Planning Self-Assessment
  3. Change Management Self-Assessment
  4. Estimating Self-Assessment
  5. Scheduling Self-Assessment
  6. Cost Control Self-Assessment
  7. Progressing Self-Assessment
  8. Forecasting Self-Assessment

Appendix A - Definitions of PCMS and Seven PCMS Functions

- Project Controls and Management System (PCMS) includes

  the people, processes, and tools for the planning and execution of all phases of capital projects including, but **not limited to**,

  estimating, planning, scheduling, change management, cost control, progressing, and forecasting.

- The **functions are co-equal**, but may receive **different emphasis** during the project phases.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Planning:

❖ The process devoted to clearly

1. identifying,
2. defining, and
3. determining

the **execution means** and **methods necessary** to achieve project goals and objectives **before initiation** of execution.

Planning may involve **work packaging**.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Change Management:

❖ The **process** of effectively

1. identifying,
2. evaluating, and
3. making decisions

on **new** or **revised**

scope/execution methods and monitoring implementation,

all in an **expeditious** and **systematic** fashion.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Estimating:

- ❖ The art and science of **predicting**
  1. cost,
  2. time, and
  3. resources

     to deliver a scope.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Scheduling:

- ❖ The art and science that results in a **time-phased plan** of activities that indicates what is to be done, when, by whom, and with what resources.
- ❖ **Work packaging** is included in scheduling.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Cost Control:

❖ The process to catalog and analyze

1. budgeted and
2. actual expenditures

of activities for purposes of **timely identification** of

cost trends,

problems and

opportunities

during the course of the project.

❖ Cost control is **not cost accounting**.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Progressing:

❖ **Determining** the **status** of completion using a **consistent method**, which should include earned value.

Appendix A - Definitions of PCMS and Seven PCMS Functions

❑ Forecasting:

❖ The process of **continuously predicting** the final outcome of cost, time, and resources required to complete a scope.

Appendix A - Definitions of PCMS and Seven PCMS Functions

- **ALL PCMS functions** provide valuable data for the planning and execution of future projects.

Appendix A

- Checklist

کنترل پروژه پیشرفته و ارزیابی عملکرد در پروژه‌های پیچیده

(بر اساس اسناد CII)

فصل پنجم:

بررسی ۱۳ روند موثر بر عملکرد کنترل پروژه

ارائه دهنده:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

CMAA Authorized Trainer

دانشگاه Illinois Tech آمریکا

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What we will learn?

- Analysis of the Effect of Each Trend on Key Project Controls Functions
- Trends and Implications
  1. Sophistication of information technology
  2. Project complexity
  3. Speed of project execution
  4. Recognition of changes
  5. Changing owner-organization direct involvement
  6. Globalization
  7. Outsourcing
  8. Graying of PCMS
  9. Contractor specialization
  10. Increase in regulatory oversight
  11. Distribution of project risks among and within organizations
  12. Virtual performers on project teams
  13. Labor and materials availability and price elasticity
- Identification of Corrective Actions Corresponding to Each Trend

Analysis of the Effect of Each Trend on Key Project Controls Functions

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Introduction

- While **several changes** in the implementation of project controls and management systems have occurred in **the last several decades**

  (perhaps **most visible** in the ways that **information technology (IT)** has accelerated reporting of project controls information),

  RT 244 concludes that the **principles** of PCMS have **not changed**.

So, what changes occurred?

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Trends

- These changes have been **distilled into 13 trends** with associated implications for PCMS. **These trends** are:
  1. Sophistication of information technology
  2. Project complexity
  3. Speed of project execution
  4. Recognition of changes
  5. Changing owner-organization direct involvement
  6. Globalization
  7. Outsourcing
  8. Graying of PCMS
  9. Contractor specialization
  10. Increase in regulatory oversight
  11. Distribution of project risks among and within organizations
  12. Virtual performers on project teams
  13. Labor and materials availability and price elasticity

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Trends

- The **trends** are **not ordered** in terms of **importance**.
- Despite some overlap, they are meant to convey the **principal influences** on PCMS implementation **currently observed** in the industry.
- The relative importance of a **given trend** may **vary** by project and industry sector, although all are seen as important.

Trends and associated recommendations

- The **trends** are described in this section.

- **Appendix B**

  separately details **prioritized recommendations** derived from the **trends**;

  these recommendations should be considered after review of the **following discussion**.

Trends and associated recommendations

- **RT 244** generated the trends and associated recommendations from a series of structured discussions.

- A **review** of the existing PCMS literature and input from other CII members by means of an **initial survey** also contributed to **trend definition** and **description**.
  - Implications, remedies, and leveraging opportunities were generated for **each trend.**

Because the trends were found to overlap in their influence on PCMS, the recommendations have been separated from the discussion of the individual trends.

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Recommendations

- **Recommendations** were **subsequently** ranked and prioritized in a **two-step process** by the research team.

- The research team **interviewed experts** in project controls and management systems to **validate** these trends and recommendations;

  these experts **reviewed** brief write-ups of the trends for **context** and then were asked about the **implications** and **recommendations**.

Their comments are reflected in the final discussion.

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Implementation of the recommendations

- **Implementation** of the recommendations detailed in **Appendix B** should help CII members adapt their PCMS program for success in **response** to the 13 trends.
- The **26 recommendations** have been **rank-ordered** as well as given an **overall importance rating** on a 1–10 scale (10 being highest).
- Ideally, the **recommendations** should be reviewed after a reading of the **description** and **implications**.
- Each **recommendation** is specific, but is **best viewed** in the overall context of all recommendations and trend discussions.
- **Resources** (related CII publications) have been **identified** for each recommendation for more detailed action.

Introduction

- **While** the recommendations and discussion of the trends can be seen as a **stand-alone document**,

  companies wishing a comprehensive **review of their PCMS** should **add** the function **diagnostic assessment** questions presented in **Appendix A**.

- An **assessment** of

  1. the seven functions as well as
  2. the broader context provided by the 13 trends and associated recommendations

  provides a **well-rounded review** of an overall project controls program.

- The **team** taking the **functional self-diagnostic tool** should be involved in the review of recommendations and trends, and

  senior leaders should **combine** the **results** from both assessments into an appropriate action plan.

Trends and Implications

(Sophistication of Information Technology)

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Summary

- **Information technology (IT)** has become **increasingly sophisticated**.
- Among **several benefits**, IT allows for analysis of massive amounts of information, speeds the entry and dissemination of PCMS data, and offers the opportunity for innovative discovery and exploration of reports (e.g., through business intelligence tools).
- Moreover, **IT tools and capacities** make it **easier to integrate PCMS systems** with **other** project management and corporate IT systems (e.g., 4D CAD, accounting).
- A **key negative aspect** is that IT can
  1. place a focus on data entry and
  2. create an overreliance on computing tools,

  leading to **less time/experience** in the **interpretation** of PCMS **output** for **management decisions**.

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Discussion

- In recent decades, **IT sophistication** has dramatically **increased**, particularly in tool efficiency.
  - By allowing one to **track projects** at a minute level of detail in near-real time, the details and intricacies of a project can be **more accurately** discerned.
    - ✓ The information is **more reliable**, with less human error.

- The **daily turnaround** of data, combined with the system capability and diversity in platform and report format,

  allows the **project stakeholders** to discern impacts more easily.

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Discussion

- IT also has allowed the **integration** of data sources (within and outside of PCMS).

- This **integration** allows for **better benchmarking and metrics**, with **more historical** variables and data available.

- Technology can also act as a leveler and promoter by helping to **standardize practices** among **less sophisticated organizations**.

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Discussion

- **Despite IT advancements**, PCMS has not kept pace with the technologic sophistication of other industries.

- Managers of PCMS systems are **only now beginning to examine** the possibility of using **computerized analytical tools**,

  which can provide automated and integrated forecasting and trending tools and processes.

  - Such tools, often called **business intelligence**,

    represent the **cutting edge** of PCMS information technologies.

Discussion

- IT benefits also bring **negatives**.
  - **Advancements** in computer technology have made changing the schedule almost too easy,

    often allowing a **project team to lose sight** of the project as well as control over it.
- The **information and PCMS systems** can be **too large and complicated** and may contain too much data.
  - Not only has the **quantity** of the data increased dramatically,

    the **data require much more** consideration to organize, sort, and filter.
- In addition, **erroneous** data once entered and **not recognized**

  circulates just as rapidly as correctly keyed-in data.

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Discussion

- **Collecting data**, **unfortunately**, has often taken on **more importance** than interpretation and analysis.
  - **Every piece** of data has **some decision associated** with it.
- The computerization of project controls information provides an imprimatur of authority, and a computer generated report is **often accepted without regard** to its source or the quality of its data.
- The **accuracy** and **validity** of data needs to be **constantly challenged**.
- PCMS personnel must assure that accurate data is being collected, evaluated, and analyzed.

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Implications

- Daily turnaround of data – data no older than one day/shift
- Possibility of computerized analytical tools (business intelligence tools)
- No limit on quantity of data managed
- More reliable information – less human error
- Field entry of data – access to data at the source and input only once
- Integration of data sources (within and outside of PCMS)
- Flexibility in report content and format – project stakeholders able to realize impact more readily
- Near real-time reporting and providing status – more time for decisions
- Able to show all interfaces
- Over-reliance on data
- Over-reliance on computers – lack of skilled interpreters and meaningful analysis
- Inaccurate data circulate rapidly (garbage in, stays in, garbage grows)
- Use of data from legacy systems without examining data integrity

Trends and Implications

(Project Complexity)

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Summary

- Project complexity has increased exponentially over the **past two decades**.
- This increase has many dimensions:
  - mega-projects,
  - designs that approach physical construction limits,
  - construction in remote locations,
  - partnerships,
  - data integration requirements, and
  - various project delivery systems and contracting strategies.
- Globalization, outsourcing, owners and contractors venturing into new territories, and

  geographical, social, and political factors add to the complexity of a project.

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Discussion

- The recent **increase in project complexity** **differs** in nature from the complexity of projects constructed between the 1940s and the 1970s.

- During that era, projects expanded in size and complexity in the sense that **more things were done** on a given site than before.

- Since then, the challenges have included
  1. the number of project participants,
  2. speed of project delivery, and
  3. location of the project, for example.

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Discussion

- The increase in project complexity has involved a dramatic **increase in interfaces**.
- One manifestation of project complexity is that **design can now** be developed at **multiple offices**.
- Also, the **number of deliverables** is staggering.
  - This creates the need to
    1. define the **division of responsibilities** at the beginning of the project,
    2. actively **manage** the information flow, and
    3. **build** in processes to ensure **smooth interfaces** between parties.
- **IT systems** need to be able to support both
  1. the quantity of data exchanged and
  2. the interfaces between parties.

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Discussion

- Adding to project complexity today are geographical and socioeconomic factors

  that require **project managers** to develop **diplomatic skills** in international relations.

  Language and **culture** also present new challenges.

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Implications

- Many more interfaces and hand-offs (across and within a function)
- Collection and assembly of data
- Dramatic increase in the amount of data
- More detailed planning and tracking required for all aspects of a project
- Multiple organizations and people accountable for data input
- Necessity to interface among different participants' IT systems
- Major increase in data transmission required
- Language and terminology issues across various project organizations

Trends and Implications

(Speed of Project Execution)

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Summary

- The **demand** for **increased speed** of project execution is tremendous.

- Today's projects **rarely** have sequential project phases.
  - **Fast tracking** – the practice of overlapping design and construction – now is common practice.

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Summary

- The **pressure** for faster project delivery has led to **several changes**.
  1. First, the **procurement** and **subcontract** process **starts earlier** in the project;
     - **subcontracting owners** often need to order **long-lead items** to ensure delivery.
  2. Second, the popularity of design-build and engineer-procure-construct (EPC) has **increased**.
  3. Third, this trend drives the need for **earlier staffing** of project teams.

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Discussion

- Fast track projects require **intense planning** up front and **accelerate** the strategy development and implementation phases.

- Getting the job kicked off as quickly as possible requires standard systems, structures (e.g., reporting), and templates.

- It is useful to have **templates** that define
  1. the division of responsibilities and
  2. the paths information

     should take between and among project teams.

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Discussion

- Fast track projects **sometimes** require the **schedule** to be planned backwards,

  starting from the **product need date**.

- The **planning phase** does **not allow much time** for details.
  - This **trend calls** for reliance on standard procedures and systems within the organization.

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Discussion

- Keeping a **database** of historical projects gives an organization a **competitive advantage.**
  - For example, an established historical project database can re**duce the amount of time** required to develop a schedule.

- The key is to **put information in a format** that allows one to base projects on a **common ground**.

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Implications

- Pre-planning and setup time shortened
- Early staffing required
- Planning can involve less accurate details
- Shortened timing and increase in number of interfaces
- Overlap of all phases
- Reliance on standard systems within the organization – less customization
- Emphasis on the need for orderly management of data (may or may not be near real-time data)
- This trend exacerbates all trends other than Trend #1 and #10.

Trends and Implications

(Recognition of Changes)

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Summary

- **Change management** is one of the greatest challenges to PCMS.
  - As organizations report **more changes**, they are increasingly emphasizing the performance of the **PCMS change control system**.
  - **Everyone** then becomes responsible for the **identification of changes**, and the **number of reported** changes increases.
  - This decrease in barriers for bringing changes forward results in **more timely change management system.**

However, **increased recognition** of changes requires the **project team** to be **more knowledgeable** about contracts.

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Discussion

- Change management is the **responsibility** of the **entire project team**.
  - **Project controls facilitate** the identification of changes.
- The **greatest** change management **challenge** faced by a project team often lies in getting a **good understanding** of the project basis (e.g., **what the estimate includes**).
- Today, organizations **strive to understand** the impacts of all changes and **look to hire** project managers who can maintain an **effective change control system.**
- For **contractors**, recordkeeping and archiving of databases become **more important**.
- Also, changes and risks have some **correlation**;
  while changes can be **used to mitigate risks**,
  they **can also increase** risk exposure.

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Discussion

- The **change control plan** defines **how** changes will be **handled** across project phases.

- **Part** of the change control system is to review each change and its impact upon project schedule, costs, and goals **before accepting** the change.

- Changes in the **installation and startup** phase have the **greatest and usually the most negative** impact upon project success.

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Implications

- Need for more individuals knowledgeable about contracts
- Decrease of the barriers for bringing changes forward – a more timely change management system
- Need for more forecasting
- Increase in the sophistication of scheduling techniques – acceleration and work force loading support analysis of changes

Trends and Implications

(Changing Owner Organization Direct Involvement)

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Summary

- Many industries have seen a **shift in owner** organization **direct involvement**.
- This started with a **general downsizing** of owner's engineering, construction, and PCMS teams and a **resulting shift** of responsibilities to the general contractor.
- This leads to the **popularity** of alternative project delivery systems such as design-build and EPC.
- Conversely, the **contractor** has to **increase the number and capabilities** of people that are assigned to the project because they are now essentially the project leaders.

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Discussion

- **After the global building boom** in the late 1970s,

  owners invested little money and stopped hiring due to a **decline** in general economic conditions and the resulting cost reduction efforts.

  - This shift led to **more dependency** on **contractors**.

- During most of the 1990s, **owners** did **not feel much pressure** because the **contractors** still had **project controls capabilities** adequate to the amount of work required.

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Discussion

- **As the 21st** century **began**,

  increases in the numbers and complexity of projects,

  the retiring work force, and

  lack of recruiting in past years

  caused owners to have significant issues with **contractors' ability** to plan, schedule, track, control, and estimate project costs and schedules.

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Discussion

- Since **costs** of materials and labor rates have **increased significantly**,

  the **need** to plan, track, and estimate **project costs** is **increasingly important**.

- With so much demand,

  contractors cannot provide resources for all the projects, and

  owners are building internal teams (sometimes including former contractor employees) to **validate contractor** estimating and cost control.

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Discussion

- **Despite** this **recent shift**, the **contractor** is often the lead on projects.
- While more responsibility is put on the contractor, owners **still need** to be involved in order to **get accurate information** and **make timely decisions**.
  - In particular, lack of owner involvement can be **detrimental** on projects that require shutdowns.
    - ✓ One trend observed by some contractors and owners is **early involvement** between the contractor and owner team before the contract (CMA/ACM and CMAR).
      - The **owner pays** for a six-month pre-contract design period; at the end of the six months, the **parties agree** on project **scope** and **design**.

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Implications

- More inconsistencies in owner requirements
- Loss of single-point decision maker in owner organization
- Contractors not constrained by owners' choice of IT systems (with a few exceptions)
- Increased burden on contractors to lead the PCMS effort
- Fewer owner personnel and more integrated teams – more EPC
- Contractors required to use same team on repeat projects
- Increased scope of work for contractors (e.g., tracking owners' costs)

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Implications

- Some implications from the project complexity trend that apply:
  - Need for more detailed planning and tracking for all aspects of a project (variables, activities)
  - Major increase in data transmission
  - Many more interfaces and hand-offs (across and within a function)

Trends and Implications

(Globalization)

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Summary

- **Globalization** requires organizations to learn **how to work within** an international setting, with different **cultures**, **skill sets**, and **language** capabilities.
  - Contracting and execution preferences **vary greatly** around the globe.
  - Constructing in a **foreign country** may require owners and contractors to develop relationships with **local governments and residents**, which may require compromises and additional resources.
- **Foreign personnel** may also require additional training and supervision to comply with company standards and best practices.
- **Globalization** also affects how the **PCMS IT system** is deployed.

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Discussion

- Through globalization, owners and contractors have **enlarged their markets** tremendously.
- Owners may choose from an **expanded list** of contractors; the contractors have the ability to seek new clients.
- Another **advantage** is that contractors can seek out **low-cost centers** for engineering, materials, and vendors.
- **Globalization**, however, is also **forcing** companies to **close the pay gap** between different countries.

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Discussion

- **Globalization** requires project personnel to learn about different cultures and norms.
- **Alignment** between the various parties on a project is **crucial**.
- **Specific terms** are needed in the **contract** and its **specifications**, particularly with respect to PCMS information flows.
- When working in **multiple locations**, **communication** is key.
- It is important to develop an interface management plan especially in the **initial stages** of the project.
- Such a plan ensures the **smooth flow** of information during execution.
- Similarly, **attention** must be paid to IT linkages across **corporate boundaries**.
- **Differences** in cultural norms, reporting standards, and information flow generally become **greater** in a global environment, **exacerbating** communication and management difficulties.

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Implications

- Multiple locations
- Discrepancies of pay based on location
- Increased interfaces
- 24-hour data inputs and outputs
- Increased need for system integration
- Timing of data inputs and outputs across locations
- Language and terminology issues
- Alignment of cultural differences required: ethics, change management, contracts
- Reliance on standard IT systems and documented practices and procedures
- Increased need for location indices (productivity and labor rates, import duties, logistic costs, training and development requirements)
- Need for timing of payment in the estimate

Trends and Implications

(Outsourcing)

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Summary

- **Outsourcing** for projects comes in **many forms**;

  the range can include all aspects, including typical owners' work, engineering design, procurement services, construction management, and construction.

- Specifically for PCMS, outsourcing can be thought of in several ways, including:

  1) outsourcing of owner PCMS requirements to independent third parties,

  2) contracting PCMS resources to supplement owner organizations, and

  3) requiring the delivery organization (contractor) to deliver against defined project planning-; estimating; scheduling; cost control; progress tracking; and reporting requirements.

  Each approach can put individual project PCMS at risk.

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Discussion

- **Outsourcing** became **popular** during the **late 1990s** as technology allowed **rapid** and **accurate** transmission of data, communications, design, and drawings as well as analyses by individuals.
- The **recent surge** in outsourcing shows that this **trend is growing**.
- **Lack** of internal resources, specialization of the work force, and cost savings are all reasons for outsourcing.
- The **lower costs** come from **smaller companies** with **less overhead** or companies in **less costly areas** with **lower employee costs**.
- The key to managing outsourcing is to **manage the environment** by **aligning the experts** on the project.

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Discussion

- **Outsourcing** creates more interfaces and **increases** the **quantity** of data managed.

- **More interfaces** have to be defined, quantified, controlled, graded, and managed.

- Outsourcing thus expands the **demands on IT systems** to transfer information across interfaces.
  - **Owners**, however, should take care in **prescribing IT systems** to **contractors** since that may **undermine** the contractor's expertise and internal systems development.

- **Interoperable systems** are seen as a **key to successful IT support** for outsourcing.

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Implications

- Additional contract management
- Unaligned methodologies (design, purchasing, manufacturing, construction)
- Implications from the project complexity trend apply:
  - Many more interfaces and hand-offs (across and within a function)
  - Collection and assembly of data
  - Dramatic increase in the amount of data
  - More detailed planning and tracking required for all aspects of a project (variables, activities)
  - Multiple organizations/people accountable for inputting data
  - Need to interface among different participants' IT systems
  - Major increase in data transmission required
  - Language/terminology issues across various project organizations

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Implications

- Implications from the globalization trend apply:
  - Multiple locations
  - Discrepancies of pay based on location
  - Increased interfaces
  - 24-hour data inputs and outputs
  - Increased need for system integration
  - Timing of data inputs and outputs across locations
  - Language and terminology issues
  - Alignment of cultural differences required: ethics, change management, contracts
  - Reliance on standard IT systems and documented practices and procedures
  - Increased need for location indices (productivity and labor rates, import duties, logistic costs, training and development requirements)
  - Need for timing of payment in the estimate

Trends and Implications

(Graying of PCMS)

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Summary

- This trend refers to the **general deterioration** of the PCMS work force in terms of demography and skill sets.
- Many events, such as the decrease in **hiring in the early 1990s**, led to a **shortage of PCMS personnel.**
- As many **experienced PCMS personnel** are on the verge of retirement, knowledge retention and transfer are especially important.
- Many believe that the **wide adoption of IT** and **frequent evolution** of technology has led to technology-focused training programs,

  which **often undermine**, if not neglect, the **analytical skills** needed in interpreting project information.

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Discussion

- **Early efforts** at implementation of project controls systems relied on **hand-calculated methods.**
- By definition, **personnel using these methods** understood the data sources and calculation methods **behind PCMS techniques** and grew to understand the links between project conditions and project controls reports.
- With the **advent of modern** computing, PCMS tools became computer-based.
- **Most training** concentrated on the operation of these new tools.
- The training has had to be **conducted iteratively** as the **computer process** has improved and the complexity of the tools has increased.

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Discussion

- This has resulted in **two skill sets** in the PCMS.

1. The **first set** consists of those who

   can use the tools, understand the process, and are capable of understanding where a project is headed and make the necessary corrected action.

2. The **other skill set** can be characterized as those who

   are weaker in the understanding of the mechanics of project control, but are extremely efficient in the operation of the computerized tools.

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Discussion

- These individuals are **limited** by their **lack of field experience**.
- **Unfortunately**, the personnel with the **most thorough knowledge** of **PCMS** are **near retirement** and on the verge of **leaving the work force**.
- The **younger generation**, while knowledgeable about computer systems, often **lack the other skills.**
- This gap has been **exacerbated by reductions** in **hiring in recent** decades.
- Most companies and educators seem to **recognize this trend** and have started programs to **hire new individuals** and get them **trained as rapidly as possible**.

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Discussion

- **Compared to twenty or thirty** years ago, project controls has become a **specialized area of expertise** with its own functional groups and career tracks.
  - However, it is difficult to do project controls well without on-site experience.

- It is also **difficult** to **get site personnel** to transition into project controls.

- Another challenge is the **mobility** of the **work force**.
  - These **conditions** tend to **reinforce** the situation where a project controls computer specialist is in a **key position**,

    but has **limited skills** in **interpretation** and **analysis**.

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Implications

- Dramatic need for training
- Need to attract people to the profession
- Systems need to be process-focused
- More standardization of IT system and procedures/processes
- Less experience-based knowledge available
- Increased risks
- Increased need for automation and sharing of resources with other functions and PCMS
- Need for more cross-training
- Inadequate amount of PCMS personnel for project needs

Trends and Implications

(Contractor Specialization)

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Summary

- As **owners strive** to pass more risks on to **contractors**,

  contractors are **focusing** on their core competencies and

  in many cases **seek ways** to shift or share **risk** with others.

  - This has **significantly increased** the **number** and **responsibility** of project players.

- **Execution specialization** has diluted PCMS expertise and increased interfaces and responsibilities.

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Discussion

- While **past practice** had contractors self-performing large portions of a project,

  modern practice has seen **increasing specialization** and the **work divided** among several subcontractors and fabricators.

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Discussion

- However,

  specialization has also **resulted** in the **contractor's loss** of detailed knowledge of project tasks,

  a loss attended by concomitant **difficulties in coordination**.

- The decision to **hire specialty contractors** needs to be made **early on**,

  which means that **project** and **work package definitions** need to be completed **even earlier**.

- Also, it is important to **communicate** expectations up front on a project.

- A challenge is that it is **difficult to get** the **specialized contractors** to communicate PCMS information

  once the **lump sum contracting method** is in place.

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Implications

- Increased complexity of interfaces
- Need to make earlier decisions regarding personnel and strategy implementation
- Need for system integration
- More planning
- Increased management oversight
- More PCMS specifications in contracts
- Need for more interfaces between PCMS systems and the MRP systems used with fabrication and modularization.

Trends and Implications

(Increase in Regulatory Oversight)

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Summary

- The **regulatory bodies**, including environmental, safety, security, and financial agencies, are becoming **more involved in projects**.
- **Lawyers** are omnipresent on modern projects due to significant increases in personal injury, liability, and traditional **construction disputes**.
- Failures to obtain appropriate permits on time and the need to comply with them throughout the project can have significant **impacts** on project cost and schedule.
- PCMS must make sure **all regulatory oversight** needs for compliance are captured and **put into the schedule**.

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Discussion

- **PCMS** is not directly responsible for the **permits** and **other deliverables** related to **regulatory oversight**,

  but needs to **capture** the critical items in the schedule and ensure compliance.

  - The nature of **this trend** requires **project personnel who understand** the **regulatory requirements**.

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Implications

- Complexity of systems and interfaces
- Risk management – forecasting the impact on cost and schedule of these activities (e.g., the unpredictability of approved processes affects planning and forecasting)
- Recordkeeping
- More planning
- Impacts on cost and schedule due to cultural differences, depending on country
- Increased fines for noncompliance
- Possible restrictions on IT per government and national company policies

Trends and Implications

(Distribution of Project Risks among Organizations)

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Summary

- Increasingly, owners assign **increased responsibilities to contractors**, thus requiring contractors to assume more risks.

- Many project delivery methods (EPC), contracting (fixed-price) and financing strategies (build-operate-transfer) provide frameworks for **such shifts of risk**.
  - These risks are also increasingly being **shifted among** key suppliers and vendors.

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Discussion

- **Risk management** is a **growing discipline** within the **ranks of PCMS**.
- The **demand on PCMS** will increase as **more risk management** is required.
- Being able to identify risks in cost and schedule forecasts is increasingly important.
- **Poor execution** could become even more costly as companies become more litigious and impose penalties and damages relating to schedule and performance.
- As owners often require contractors to **assume more risks** and **assign increased responsibilities** to contractors, the criticality of the transition from a contract to a project execution plan and **budget will only increase**.
- **Early evaluation** and identification of risks on the project level is especially important.

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Discussion

- With the **increased complexity** of projects, of **globalization**, and of owner organizations

  there will be an **increase in the number of interfaces** and handoffs across and within functions,

  requiring more items to be **interfaced** among a variety of IT systems.

- This requires an **upgrade** in data transmission systems and procedures to support effective risk management controls.

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Implications

- More thorough-going demand on PCMS
- Criticality of the transition from contract to project execution plan and budget (to establish effective control baselines)
- Need for forecasting methods to address identified project risks
- Implications from the project complexity trend apply:
  - A lot more interfaces and hand-offs (across and within functions)
  - Collection and assembly of data
  - Dramatic increase in the amount of data
  - More detailed planning and tracking required for all aspects of a project (variables, activities)
  - Multiple organizations and people accountable for inputting data
  - Need for interface among different participants' IT systems
  - Major increase in data transmission required
  - Language and terminology issues across various project organizations

Trends and Implications

(Virtual Performers on Project Teams)

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Summary

- **Global projects** and **outsourcing practices** require project **personnel to collaborate electronically**, often meaning that people are meeting in a "**virtual" environment** to collaborate and keep the project moving.
- **Current workforce trends** have also increased the number of people that work from **home**.
- Having a **large number of virtual performers** creates **unprecedented challenges**, requiring
  1. **standardization** of procedures and methodologies,
  2. efficient **interface management** and **data transmission processes**, and
  3. **recognition of differences** in language, terminology, and culture.

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Discussion

- **Many individuals interface** with but **never see the actual project** beyond their specific contribution.
- **Virtual performers** bring **new challenges** to communication.
  - **When communicating** by e-mail, people may omit information and thus make **correct interpretation difficult**.
    - ✓ The key to this is to **"over-communicate."**

      Managers should establish **review** and **approval processes** and **IT systems** that support virtual performers.

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Implications

- Design review, checking, and approval must change
- Increased dependency on technologies – some systems have restrictions on access
- Security restrictions on technology transfer
- Difficulty in demonstrating contribution to time charges
- Complexity of interfaces
- Dependency on standard system and processes

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Implications

- Implications from the project complexity trend apply:
  - Many more interfaces and hand-offs (across and within functions)
  - Collection and assembly of data
  - Dramatic increase in the amount of data
  - More detailed planning and tracking required for all aspects of a project (variables, activities)
  - Multiple organizations and people accountable for inputting data
  - Need for interface among different participants' IT systems
  - Major increase in data transmission required
  - Language and terminology issues across various project organizations

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Implications

- Many implications from the globalization trend apply:
  - Multiple locations
  - Discrepancies of pay based on location
  - Increased interfaces
  - 24-hour data inputs and outputs
  - Increased need for system integration
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  - Alignment of cultural differences required: ethics, change management, contracts
  - Reliance on standard IT systems and documented practices and procedures

Trends and Implications

(Labor and Materials Availability and Price Elasticity)

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Summary

- This trend is the result of multiple factors, including
  1. global material demand,
  2. disaster relief resource pull, and
  3. immigration policies, among others.

- It calls for **adjustments** to **increase forecasting capabilities** to <u>better integrate changes</u> in availability and price of labor and materials.

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Discussion

- One of the **biggest changes** on the modern construction project is the **inconsistency** of labor skills and construction management skills.
- **PCMS** must be aware of possible changes to **predict** inefficiencies and delays due to

  lack of skills, lack of work force, and changes in material costs due to availability.
- Knowing this, the **project manager must use PCMS** and **tools** to verify skill sets during the **project development phases**;

  these resources must also be used to **improve estimates** based upon **newer labor efficiency rates** and

  other relative relationships such as location, language barriers, local customs, and culture.

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Discussion

- A **significant current issue** is the **decrease in the labor skill set**.
- As **new work centers** are set up on a global basis, unskilled labor and supervision forces are often found.
- The **project manager** must **analyze where** the labor force will stand at the time of the execution.
- Will it remain unskilled, untrained, or be trained and in high demand?
- Will the demand affect the availability or will more unskilled labor be required?
- It is the **responsibility of procurement** to identify materials availability.
- Construction has the responsibility to identify labor and wage issues.
- **Project controls** analyzes the data provided.
  - *For example, if an additional 500 people are needed, is the solution to increase productivity or delay the schedule? PCMS must support such decision-making processes.*

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Implications

- Longer delivery time, which requires more oversight
- More in-depth assessment of risks
- More intense productivity and rework measurements
- Need for better quality assurance
- Need to be better able to take advantage of globalization/global resources to mitigate limitations of local/traditional supply sources

Identification of Corrective Actions Corresponding to Each Trend

Appendix B

- This **Appendix** details a **set of twenty-six recommendations** distilled from thirteen broad trends **that impact** the implementation of project controls and management systems.

- These **recommendations** are meant to broadly apply to PCMS and **should help teams** make a thorough review of their systems, particularly **when coupled** with the function self-diagnosis presented in **Appendix A** of this report.

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Appendix B

- **Recommendations** have been rank ordered by the RT 244 research team as well as given an importance rating on a **1–10 scale where 10 is highest**.
- **These rankings** should help companies assess the **relative importance** of each recommendation.
- **Resources** to aid companies with more specific guidance for **each recommendation are listed.**
- These are **CII publications** and are referenced by **CII report number**.

Research team

Global Project Controls and Management System Research Team

Wilson C. Brasil, Jr., Petrobras
* David D. Butler, GlaxoSmithKline (Co-Chair)
Augusto L. Cardoso, Petrobras
Ralph Dove, CH2M HILL
Darrell Earnheart, WorleyParsons
Steve E. Goodman, J. Ray McDermott
Bruce Hallock, Marsh USA
Robert C. Kurtz, Mustang
John F. Kurzawinski, U.S. Steel
Bernard Langer, Bechtel
William M. McCauley, Jr., Shell
* Cindy Menches, The University of Texas at Austin
* William J. O'Brien, The University of Texas at Austin
Bruce Strupp, CH2M HILL
Paul Thompson, Foster Wheeler
Jane Todd, Ontario Power Generation
* Peter Van Nort, Harper Industries (Co-Chair)
Menzies Wilson, Smithsonian Institution
Jiangnan Yi, The University of Texas at Austin

* Principal authors

Editor: Jacqueline Thomas

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش

تهران، بلوار فردوس شرق، مجتمع آبگینه، طبقه سوم اداری، واحد C42

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۵۰

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۴۵

info@dralavipour.com

www.dralavipour.com

@alavipour_pm

@acemi_social

@alavipour_pm

@IRANACEMI