



مدیریت فناوری‌های دیجیتال در صنعت ساخت

(بر اساس سندی از انجمن مدیریت ساخت آمریکا (CMAA))

ارائه‌دهندگان:

سیدمحمد رضا علوی‌پور (PhD, PMP, CMIT) از دانشگاه Illinois Tech آمریکا

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فصل دوم: فرآیند استاندارد برای مدیریت فناوری‌های دیجیتال در پروژه

بخش اول: مقدمه

ارائه دهنده:

سید محمدرضا علوی پور

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- ☐ Preface
- ☐ Introduction
- ☐ Construction technology
- ☐ Technology strategic planning
- ☐ The CM's role in technology management
- ☐ Conditions of satisfaction (COS)
- ☐ Project/program management plan
- ☐ Evaluating technology

PREFACE

Technology management guidelines

- ❑ These **Technology Management Guidelines** guide the **adoption** of standard technology management plans, processes, and procedures for the **construction manager (CM)** during the **execution and turnover** of construction projects/programs.
- ❑ This document uses the term “**CM**” to refer to project management and program management professionals **who lead teams** to accomplish projects/programs in the built environment.
- ❑ These guidelines **supplement the technology management chapter** in the CMAA Construction Management Standards of Practice by providing **details** of a project’s or program’s typical technology management responsibilities from **concept to occupancy**.

What impacts the CM’s responsibility?

Characteristics that impact the CM's responsibility

- ❑ Each project or program may have a set of unique characteristics that will significantly impact the CM's responsibility for management and coordination.
- ❑ These characteristics **shape** the project's/program's technology management systems.

What are they?

Characteristics that impact the CM's responsibility

❑ These characteristics include:

❖ Project/Program Type

✓ **Different project/program types** – airports, healthcare facilities, railways, hotels, bridges –

may vary in size and require different resources,

including systems, tools, equipment, and software unique to the project/program type.

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Characteristics that impact the CM's responsibility

❑ These characteristics include:

❖ Location

- ✓ Projects/programs in **different geographical** areas require
 - ❖ **Separate** engineering and construction **codes and standards**, and
 - ❖ Various **administrative requirements** will apply.
- ✓ **International projects** have additional issues, ranging from codes and standards to contractual frameworks and cultural differences.

Characteristics that impact the CM's responsibility

❑ These characteristics include:

❖ Renovation versus New Construction

- ✓ Projects/programs involving **renovation or rehabilitation** in and around ongoing operations
may involve different measuring, monitoring, and reporting requirements.

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Characteristics that impact the CM's responsibility

❑ These characteristics include:

❖ Owner

- ✓ Project/program owners may have **unique** technology management systems and requirements.

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Characteristics that impact the CM's responsibility

❑ These characteristics include:

❖ Delivery Method

- ✓ Whether delivering a project/program under a design-bid-build contract, multiple prime contracts, construction management at-risk contract, design-build contract, etc.

How about phases?

- ☐ For **simplicity**, these Guidelines refer to five delivery phases: pre-design, design, procurement, construction, and post-construction.
- ☐ However, on an **actual project or program**, these phases may **not have clear** start and end points.
- ☐ Activities may **overlap** between phases or occur in a different order.

How about services during delivery phases?

Services during delivery phases

- ❑ Further, the **CM** may **only be involved** with one phase of a project or program, e.g., the **construction phase**.
 - ❖ If that is the case, **guidance** provided in the pre-design or design phase sections **may need** to be applied during the construction phase, **if those services** are in the CM's agreement with the owner.
- ❑ Accordingly, the **CM** must **tailor** the details provided in **this document** to fit the needs of a **particular** project/program and the CM's scope of work.

Services during delivery phases

The services the CM performs may vary from those described in this document.

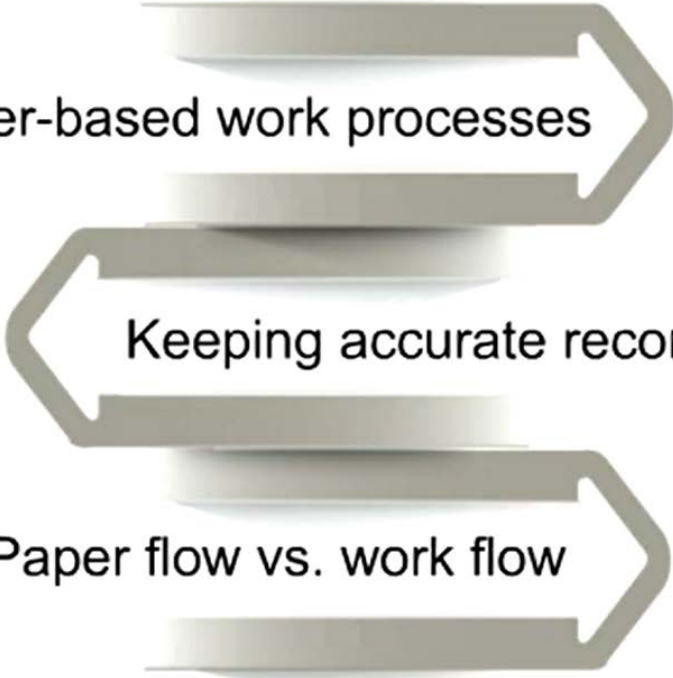
- ❑ This document **intends** to **prescribe** an industry standard of practice that the CM will **meet or exceed**.
- ❑ **Not every project/program** will require every technology management service, and a particular project/program may require **unique services not listed** in this document.
- ❑ **Whatever service** the CM provides,
if **the CM's contract agreement** includes technology management,
this **manual offers details** for delivering these services
but **does not define** a CM's scope of services for
technology management.

Use the document by court

- ☐ CMAA does **not intend** that this document be used by **courts or others** to create **contractual or legally enforceable** duties or requirements, as such duties and requirements are established by terms of the **CM's contract and the laws** of the jurisdiction in which the CM is practicing

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INTRODUCTION



Managing paper-based work processes

Keeping accurate record of status

Paper flow vs. work flow

Managing unstructured communication

Centralizing collaboration

Maintaining standards and protocols

Program management control system



Program management control system challenges

Strategic vs. tactical approach

Proprietary vs. COTS tools

Selecting the best fit tools



CONSTRUCTION TECHNOLOGY

❑ Construction technology generally refers to

1. Systems,
2. Tools,
3. Equipment, and
4. Software

used to **organize** and **manipulate**

1. Data,
2. Materials, and
3. Other resources

to **complete** a **capital** construction project or program.

What does technology management mean?

❑ Technology management may involve

automated or **semi-automated** methods

to complete specific tasks

that improve other management functions, such as

1. Quality,
2. Cost,
3. Time,
4. Sustainability, or
5. Risk.

What do we expect from technology?

Construction technology expectations

- ☐ Technology should
 1. Simplify tasks and
 2. Increase accuracy and productivity.

- ☐ Technology and innovative thought leadership can **add value** to the **owner** to
 1. Save time,
 2. Increase predictability, and
 3. Improve performance,
 4. Productivity, and
 5. Collaboration.

What to expect from CM here?

Construction manager's role in technology

- ❑ These **guidelines** provide an **overview** of the technology management topics specific to the construction manager's role.
- ❑ A construction manager (CM) should **consider** the information in this document to **enhance** the **delivery** of their projects and programs, which is possible by performing management tasks to meet owner expectations efficiently and reliably.

Where can this guideline apply?

Construction technology guidelines

- ❑ This guide provides a standard for technology management principles and practices that apply to both all delivery methods and forms of CM, including:
 - ❖ **Agency CM**, where the owner is the contracting entity with project/program contractors and the CM augments or is part of the owner's staff;
 - ❖ **CM at-risk (CMAR)**, where the CM provides construction services to owners;
 - ❖ **Design-build**, design-bid-build, design-build-operate-maintain; and
 - ❖ **Other delivery methods** (such as multiple primes, engineering procurement construction, integrated project delivery, public-private partnership, etc.).

Should the CM use this guideline in all phases?

Construction technology guidelines

- ☐ The CM should **reference** these Technology Management Guidelines during **all phases**, if providing technology management services.
- ☐ This document **outlines methods** that the CM should use **while** undertaking **management tasks**.
- ☐ Meanwhile, the **owner** should use the CM's expertise to aid the owner's organization in **all aspects** of technology, project/program development, and implementation.

What if the owner has its own technology resources?

- ☐ Note that the CM's firm (if not part of the owner's organization) may have its own **technology resources**, which the **CM can adapt** as needed to benefit the owner.
- ☐ The CM's firm may also have **dedicated technology staff** (such as a chief technology officer) **who can assist** the CM and the owner.

How to provide these services?

- ❑ Therefore, the CM must **recognize**

what resources the owner needs and

negotiate a fair CM contract with the owner (when separate from the owner) based on the scope of services the CM can provide.

- ❑ For more on CM contracts, see the CMAA Contract Administration Guidelines and CMAA Quality Management Guidelines.

What will you learn from this section?

Construction technology guideline focus

- ❑ These Guidelines provide an **overview of the management topics** specific to the **CM's role with technology**, but they are not a comprehensive review of all construction technology.
- ❑ These Guidelines provide a **standard for a CM** to evaluate and manage technology to meet an owner's needs.
- ❑ The CM (or their firm) may need to **advise the owner on the technology concepts** for project/program control.
- ❑ **Technologies unique** to the designer, builder, or other stakeholders are generally beyond this section's scope, but **each owner's requirements** for the CM will **vary**.

TECHNOLOGY STRATEGIC PLANNING

Developing your tech strategy

❑ **Comprehensive assessments** determine internal and external needs, and expectations for technology in your **business**

STRATEGIC CAPABILITIES

The company has strategic technology capabilities that exist today. An assessment will reveal how effective the technology is utilized and how relevant the technology is in today's environment. Existing strategic capabilities may also be coupled with new technologies to enhance overall performance of the business.

TECHNOLOGY STACK

An understanding of the current technology stack includes an assessment of existing licensed software, software as a service subscriptions, server vs. cloud platforms, hardware and mobile devices.

EMPLOYEE INTERVIEWS AND SURVEYS

Use of technology in the business relies on adoption by employees. Through employee interviews and/or surveys you must understand the general level of user sophistication and capabilities. This will assist in determining the readiness of the company to embrace or further improve technology.

COMPETITOR BENCHMARKING

An assessment of the competitor landscape and its use of technology is imperative when conducting any market analysis. A deeper understanding of competitors' strategies, strengths and weaknesses is a key component to assessing the market.

CLIENT INTERVIEWS

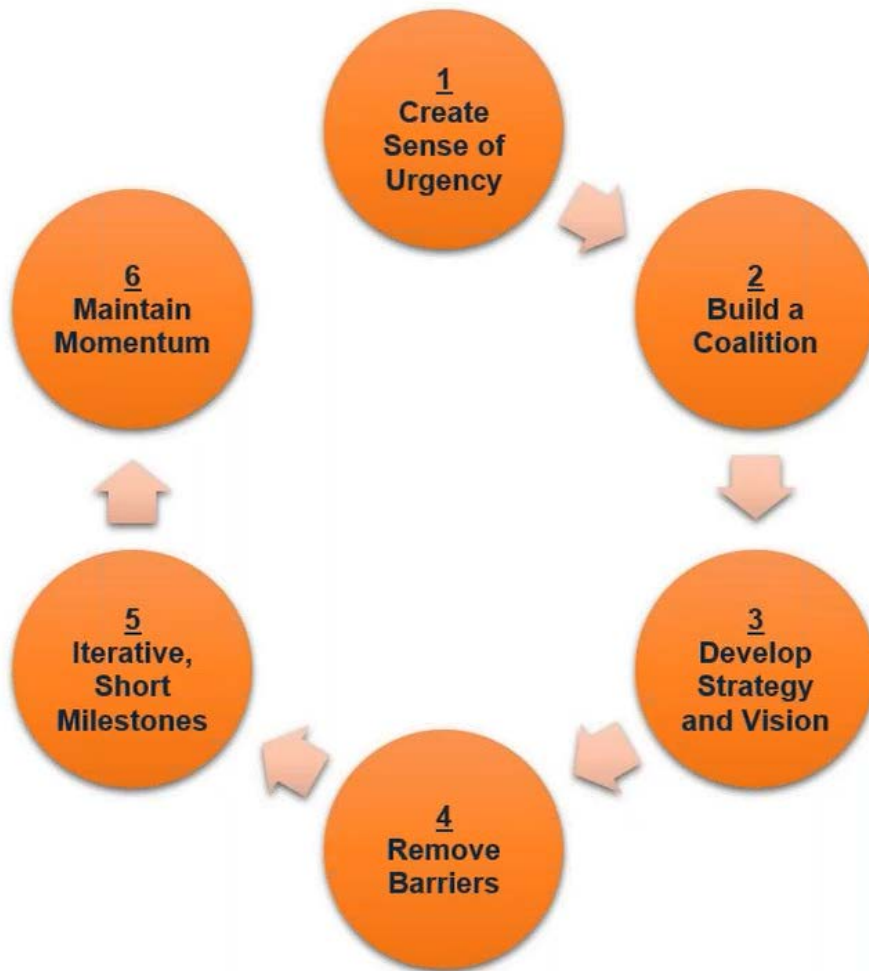
Candid client feedback is typically only available when collected by an independent third party. Moreover, However, any feedback you can collect allows you to quickly discern and prioritize strategies to increase the likelihood your company is recommended to others, enhance client loyalty and ultimately improve the company's use of technology to better meet the needs of the client.

Find the gaps and remove redundancies

- ☐ Conduct **Gap Analysis**:
 - ☐ vs. client expectations
 - ☐ vs. competitors
 - ☐ vs. employee needs/wants
- ☐ Highlight **current** system/functional interoperability issues
- ☐ Determine **redundant** systems or systems no longer used but still supported in tech stack
- ☐ Determine **associated needs** such as tech training, infrastructure, support



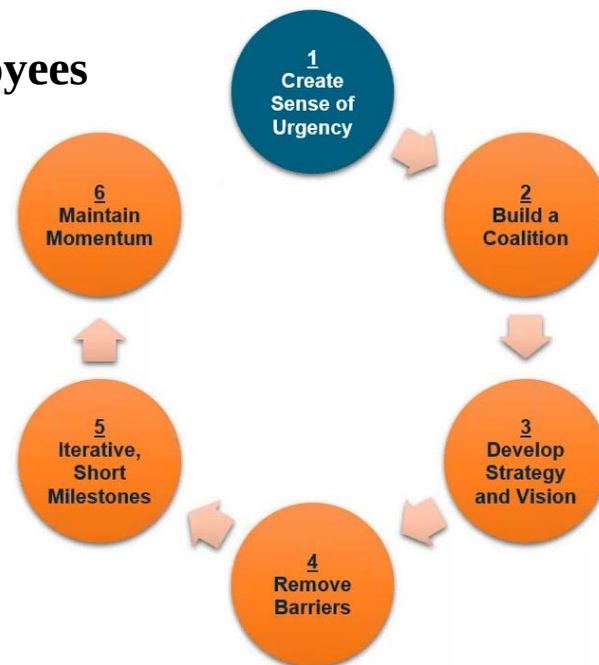
Change management best practices



Change management best practices

1. Create a sense of urgency

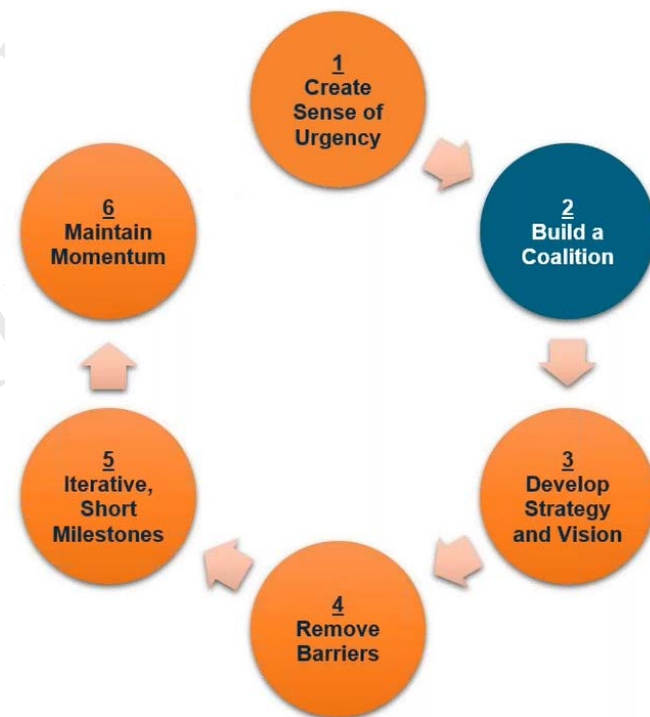
- ❖ Always tie back to the **strategic objectives** of the company
- ❖ Articulate the **business need**
- ❖ Explain the **current state** vs. **envisioned future state**
- ❖ Communicate the **impact of not making** the change
- ❖ Make the **outcome** of the change **relevant to employees**



Change management best practices

2. Build a coalition

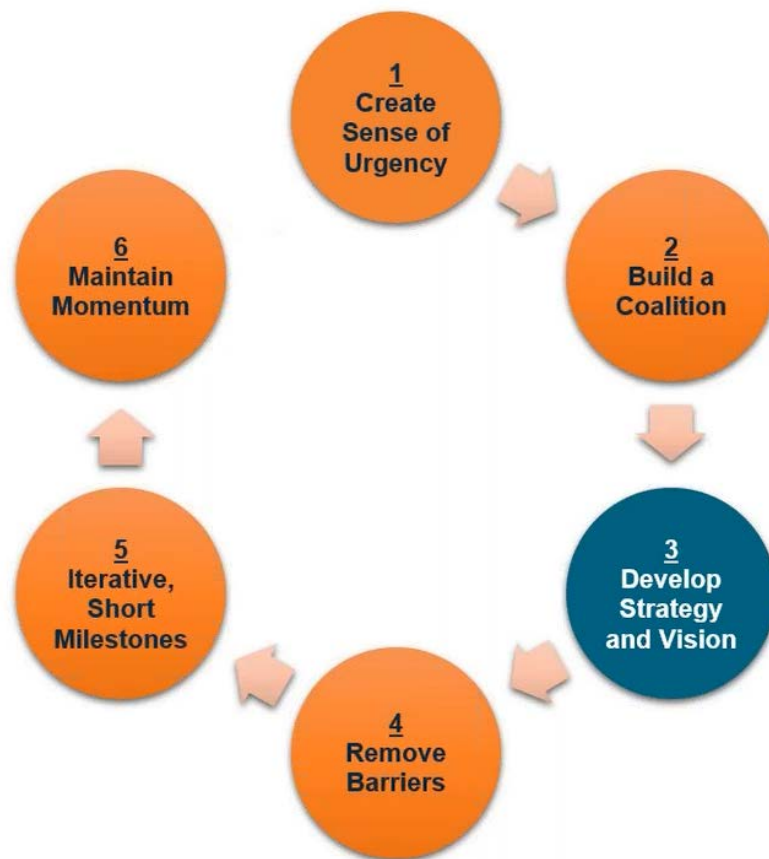
- ❖ Identify the stakeholders
- ❖ Define roles and responsibilities for those that will need to take action
- ❖ Explain the importance of **change agents**
- ❖ **Organize your change agents** into a committee to represent the company and lead the change
- ❖ **Reward change agents** in some way



Change management best practices

3. Develop a strategy and vision

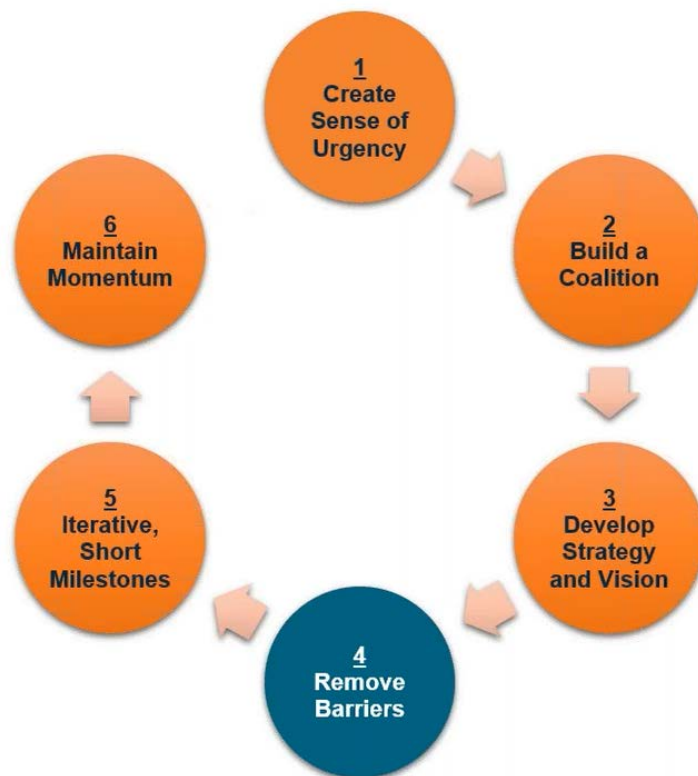
- ❖ Develop a Point of View
- ❖ Create the Tech Vision
- ❖ Conduct tech assessments
- ❖ Identify opportunities
- ❖ Derive tech strategic objectives
- ❖ Formalize a tech roadmap



Change management best practices

4. Remove barriers

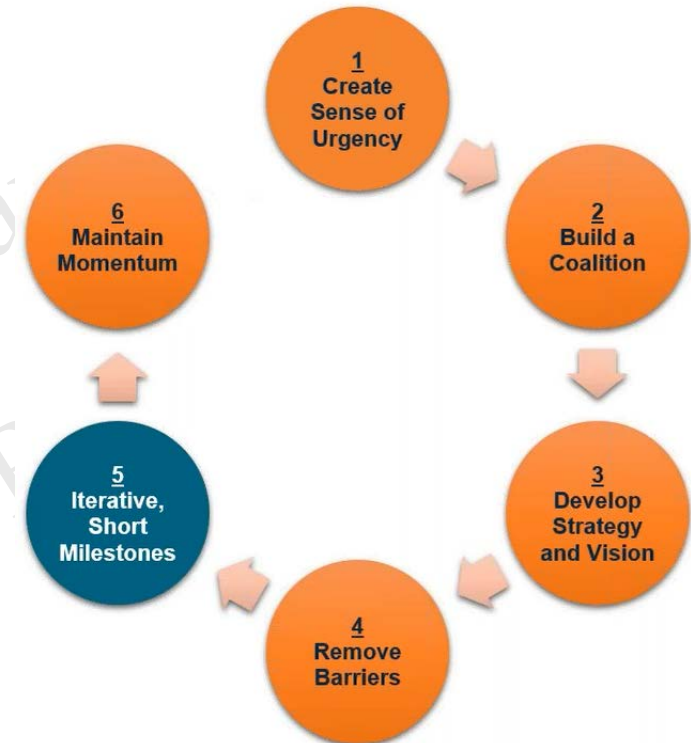
- ❖ Enable action
- ❖ Proper funding
- ❖ Allow for adequate time
- ❖ Reduce the impact of other concurrent actions
- ❖ Equip stakeholders with resources to carry out the change management process successfully
- ❖ Do not overlook training (software orientation, user training, etc.)



Change management best practices

5. Iterative, short milestones

- ❖ Create a change management plan that is **measurable**
- ❖ Allow for **short-interval planning** and **sprints**
- ❖ Schedule **more frequent mini-milestones** that roll-up into strategic milestones of the **overall plan**
- ❖ Accommodate an **evaluation of how well the process** is going and whether or not **pivots/modifications** to the plan are necessary



Change management best practices

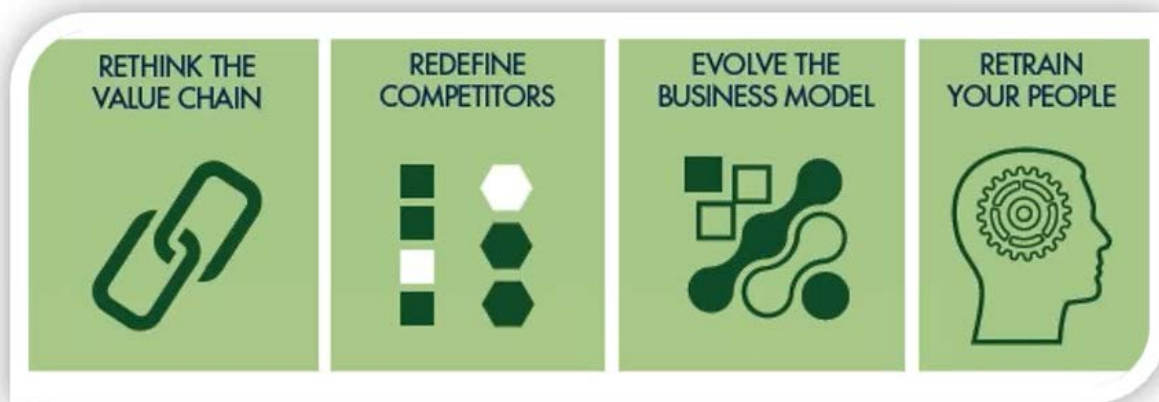
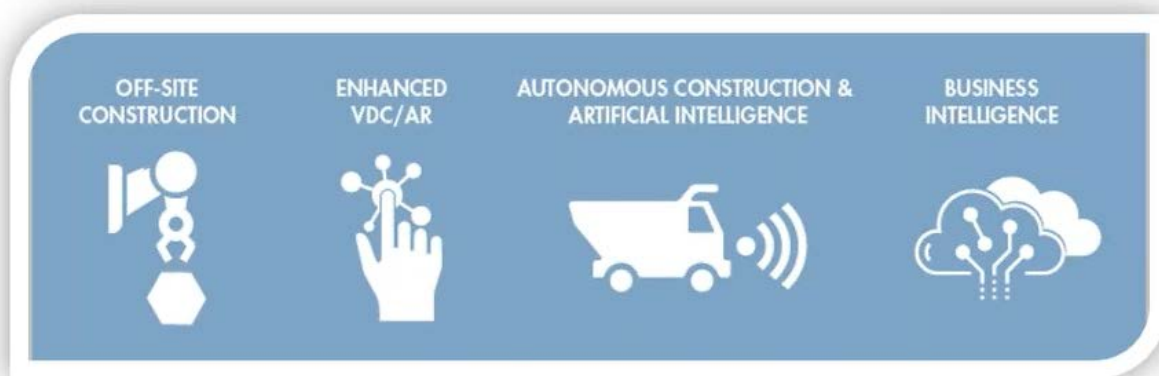
6. Maintain momentum

- ❖ **Celebrate** each mini-milestone and major milestone
- ❖ **Add members** to your stakeholder team when there is **new interest from employees** that can add value
- ❖ Encourage **feedback**
- ❖ **Remind** everyone where the **company is** on the change management path/schedule
- ❖ Promote the **Envisioned Future**



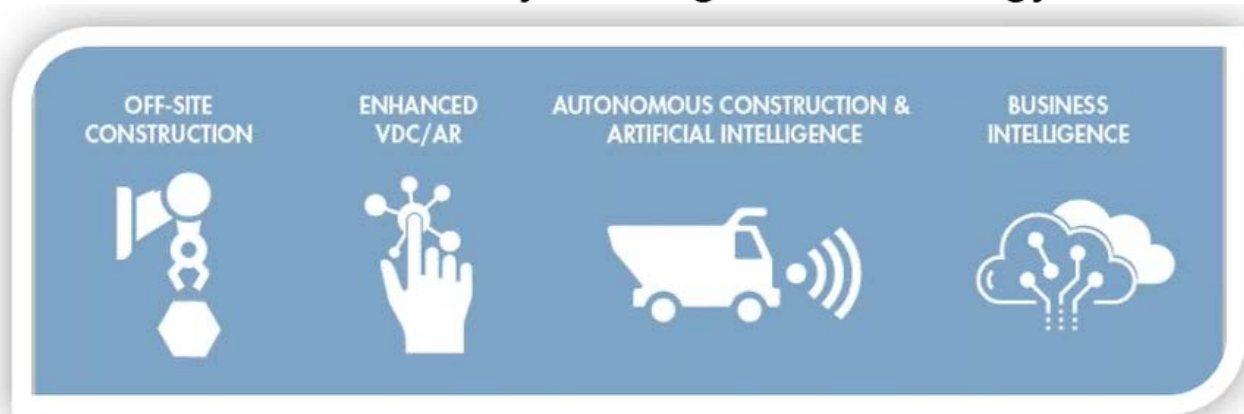
Prepare for the future

“The risk in remaining solely focused on the short term is that...firms may find themselves on the outside looking in if they fail to study external trends and adapt their business models and approaches.” - FMI Quarterly Q1 2018



Prepare for the future

The evolving value chain is just one reason to consider why a company would consider how you integrate technology

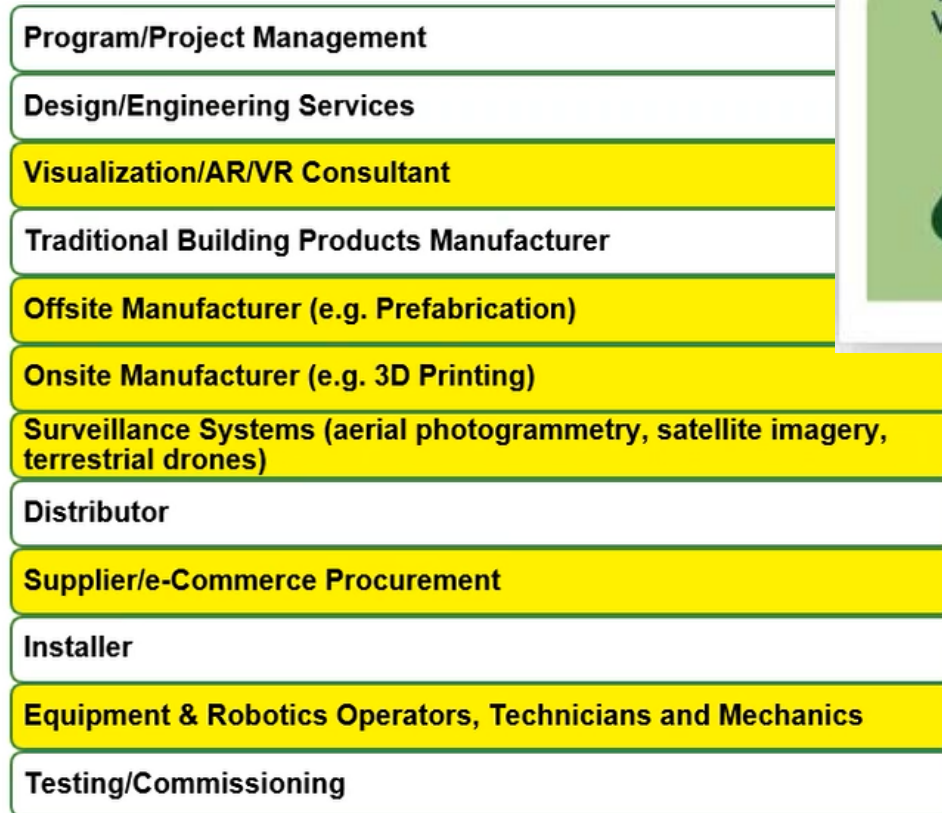


- Value Chain: The series of activities and resources which are applied in a way to create a product or services that provides value to a customer or client.

Example Value Chain of Today



Example Value Chain of Tomorrow



RETHINK THE
VALUE CHAIN



THE CM'S ROLE IN TECHNOLOGY MANAGEMENT

CM as a technology expert



A CM does not necessarily need to be a technology expert, but they should be able to manage a team to meet an owner's technology requirements.

- ❑ In other words, a CM should **understand** technology well enough to manage project/program **delivery**.
- ❑ The CM must know what **current technology options** are available.
- ❑ The CM must also know
 - ❖ Who the **experts** are
 - ❖ Who **can answer questions**, technology's ethical implications, and
 - ❖ What **new technologies** may become available.

CM primary roles

- ☐ The CM must either
 1. **Directly** advise the owner on a technology or
 2. **Connect** the owner to the appropriate resources.
- ☐ The CM understands that a **good technology solution** should be flexible, scalable, and easy to adopt.
- ☐ A CM stays current with **industry best practices** and **knows** about (and anticipates) emerging technologies.
 - ❖ However, a CM also recognizes that the **best solution** for an owner **may not be a new technology**.

The CM should use the technology to do what activities?

- ❑ A CM should be able to **use technology** to
 1. **Monitor** all phases and
 2. **Control** scope (cost, time, quality, and any other project- or program-specific requirements).
- ❖ *Examples include budget software, scheduling software, and inspection tools.*
 - ✓ However, **which technology** the CM uses may be
 1. **Specific** to the **CM's contract** with the owner and
 2. Owner's requirements.
 - *For example, a CMAR would also be responsible for the technology used to perform the work during construction.*

- ❑ A CM must **manage** technology,
not allow **technology** to manage them.

What does that mean?

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❑ In other words, a CM should **focus on delivering** the project or program to meet the **owner's required scope** (cost, time, quality, etc.).

❖ A CM should understand how to

1. **Manage** the technology and
2. **Connect the owner** to the appropriate resources,

but a CM does **not necessarily need** to be a technology expert.

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CONDITIONS OF SATISFACTION (COS)

Conditions of satisfaction (COS)

- ❑ The conditions of satisfaction (COS) are the owner's **tangible technology requirements** for the project or program.
 1. An owner's requirement is an owner's **acceptable standard** for delivering the completed structure(s).
 2. A project or program may have many technical requirements that the owner and CM must **clearly identify** and **document** in the COS.
- ❑ During project/program execution, a **well-trained workforce** that **understands** the owner's technology **requirements** performs and evaluates the work to ensure it meets the **owner's COS**.

How should it be developed?

COS characteristics

1. The COS should be specific and **help** the CM evaluate the suitability of **potential technologies**.
2. The COS may **document** the required technology and functionality which designer and builder should accomplish
(e.g., specific communications, controlled access, lighting, or ventilation systems and their performance requirements).
3. However, the COS may also **require** the **CM to use certain technology to monitor** all phases, control scope, and meet any other specific requirements.

CM roles in developing COS

- ❑ If the **CM provides** technology management **services**,
 - the CM **ensures** that the **COS complements** the owner's other relevant policies, plans, and contracts (or the CM's own, if separate from the owner).
 - ❖ For example, a CM should recognize that **some organizations** may have a separate document called a technology charter
 - that establishes **strategic technology policies** for all of the organization's projects and programs.
 - ✓ If applicable, the technology charter and COS should agree.
- ❑ The CM also ensures that **all contracts and plans** include or reference the COS to align the team's goals.

PROJECT/PROGRAM MANAGEMENT PLAN

Why technology?

❑ The CM **applies** technology and the latest trends to

- ❖ Solve problems,
- ❖ Increase efficiency, and
- ❖ Add value

to their clients and organizations.

❑ A project management plan (**PMP**) or program management plan (**PgMP**) helps the CM guide these processes.

What is PMP/PgMP?

PMP/PgMP and technology

❑ A PMP/PgMP **outlines**

- ❖ How to accomplish the owner's requirements and
- ❖ How to measure the team's performance.

- ❑ The PMP/PgMP establishes the team's scope, budget, schedule, environmental conditions, methods and procedures, and basic systems,
including which **technology** the **team will use** throughout all phases.

How about CMP and technology?

- ❑ Note that there are some project/program documents that may be
 1. **Part** of the PMP/PgMP or
 2. **Standalone** documents that incorporate the PMP/PgMP by reference.
- ❖ For example, the PMP either
 1. **Includes** the construction management plan (CMP) or
 2. **Refers** to a separate **CMP**
that explains how the team will use technology to manage construction.

How about PMP/PgMP and BIM?

- ❑ If the team uses building information modeling (BIM), the **PMP/PgMP** either
 1. Includes the BIM execution plan (BEP, sometimes known as BXP) or
 2. Refers to a separate BEP document.

How about other documents related to the technology?

Other documents and technology

❑ All other project/program documents must accurately reflect **how the PMP/PgMP**

defines

- ❖ Team's roles and responsibilities,
- ❖ Procedures,
- ❖ Tools,
- ❖ Schedules,
- ❖ Budgets, etc.,

concerning technology.

✓ For example, the CM **ensures** that the project procedures manual (PPM)
clearly defines

*team's responsibilities, levels of authority, and the systems, methods,
and procedures concerning technology.*

EVALUATING TECHNOLOGY

Technology objectives

- ❑ The CM **helps** the owner **turn** technology objectives into clear technical requirements as early as possible.
- ❖ Still, the CM must realize that the **newest** technology **may not always** be suitable for every project or program.

Why?

❑ New technologies may be

- ❖ **Untested** in the industry,
- ❖ Carry additional **risks**, and
- ❖ **More expensive** than older tools, equipment, systems, and software.
- ❖ Owners, vendors, and other stakeholders often **need time to learn and adopt** new technologies.

So, how to decide?

- ❑ When **evaluating** technology, the CM must **understand**
 1. Owner's preferences and capabilities,
 2. Communicate how technology will deliver value to the owner, and
 3. Promote a positive workplace culture.

How to understand the owner?

Understanding the owner

- ❑ A CM should **meet** with the **owner** as **early** as possible to
 1. **Clarify** the project's or program's **goals** and
 2. **Learn** what **role technology plays** in the owner's mission.

What CM should learn in this meeting?

Understanding the owner

- ❑ As part of this discussion, the CM should **learn**
 1. What **technology resources** the owner already has
e.g., the owner's information technology (IT) staff, proprietary systems, software, technology budget, etc. and
 2. **How much risk** the owner is willing to accept to design, construct, and operate the facility.
 - ✓ *For example, an owner with a **small IT department** and a **limited budget** may **not have the time and money** to train their staff to use the **newest digital technology**.*

How people react to new technologies?

Understanding the owner

❑ In the **book Diffusion of Innovations**,

professor Everett Rogers theorized that some people are **likely to adopt new ideas earlier** than others and that the spread of new ideas forms a predictable pattern.

❑ This theoretical distribution forms a bell curve, with the **majority (68%) of people** somewhere **near the middle**,

i.e., the majority of people are **willing to start** using a new technology after **they see other people** use it successfully.

Understanding the owner

According to the figure below, adopters tend to sort into one of five different groups.

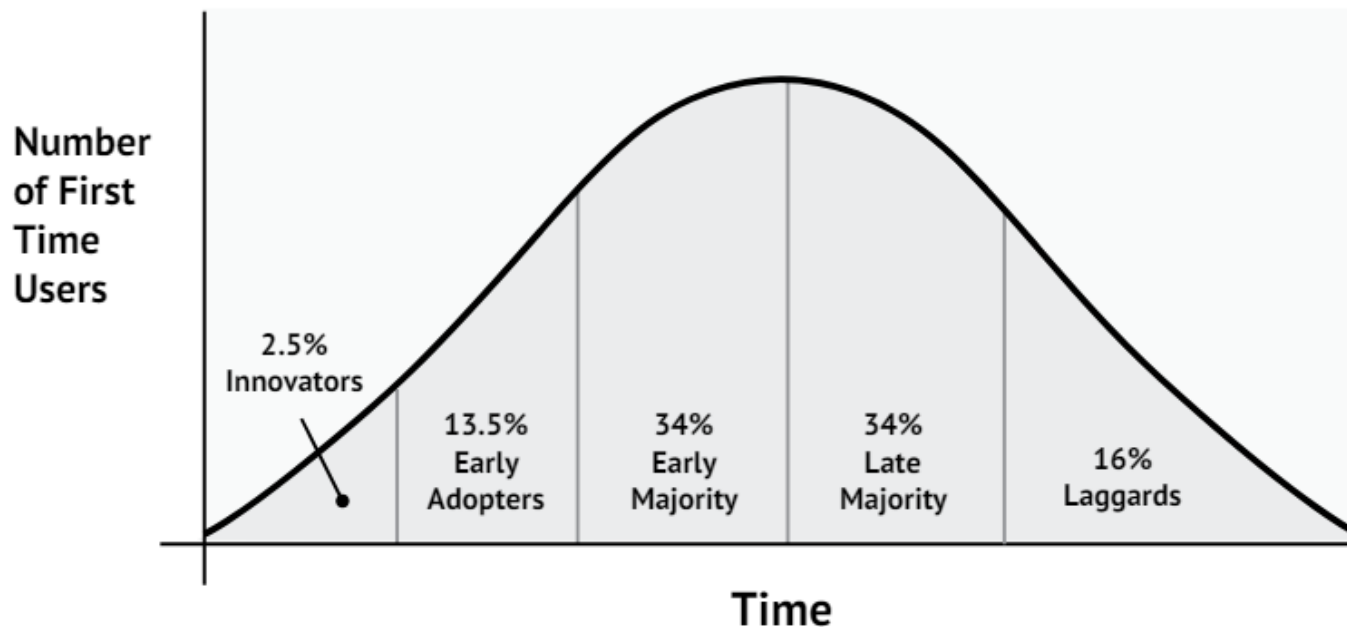


Figure 1 – Adoption Curve. Adapted from https://commons.wikimedia.org/wiki/File:Diffusion_of_ideas.svg.

How to analyze owner's risk appetite for new technology?

Understanding the owner

❑ **Rogers' theory** provides a practical framework to analyze an **owner's risk appetite** for **new technology**.

❖ For example, an **owner** may be **willing to accept** risk and gain a competitive advantage by becoming one of the first organizations in their industry to use a technology.

✓ *This type of owner might be an “Innovator” or “Early Adopter.”*

❖ However, the **opposite may also be true**—

an **owner may avoid** a new technology until their competitors have already started using it.

✓ *In this case, the owner may be in the “Late Majority” or even “Laggards” category.*

When the technology is not suitable for the owner?

Understanding the owner

❑ The latest technology may **not be suitable**

if it **severely impacts** the owner's staff, budget, risk, etc.

❖ As in all construction management practice,
the CM must carefully **advise** the owner if the **owner's desired scope** is unrealistic.

What other recommendations should be given to owner?

- ❑ Next, the CM **advises** the owner to consider technology an investment, not a cost.
- ❑ The CM must help the **owner understand** how investing in a particular technology will offer financial and other gains.
- ❑ The CM must **explain** to the owner that the right technology **enhances** project or program **delivery** by
 - saving time and costs,
 - improving quality,
 - increasing safety,
 - reducing risk, etc.





However, the CM must be careful to show the owner how a technology helps the team do the work **better**. In other words, the CM must explain that good technology makes the team more productive and efficient, but it does not replace the team's expertise.

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Technology investment

- ❑ For example, consider how digital document control software can help teams **more efficiently**

design, plan, and monitor the work than paper.

- ❑ Digital document control software
 - ❖ Helps designers **log changes** to design documents and
 - ❖ Helps the CM ensure that the team is **only using the latest versions**.
- ❑ This **efficiency**
 - ❖ **Enhances** the team's expertise and
 - ❖ Reduces **improvised solutions** on the jobsite, costs, and delays.

How the CM may be selected?

- ☐ Note that the **owner's selection** of the **CM** (if separate from the owner) may be based on the **scope of technology services** that the CM may provide.
- ☐ If the CM **provides** their **own proprietary technology services** to the owner, the **CM** must **explain how those services** are good investments for the owner

Is there any way to calculate this?

- ❑ Return on investment (ROI) is a performance measure to evaluate an investment's efficiency.
- ❑ The formula to calculate ROI is:

$$\text{ROI} = (\text{Financial Gain} - \text{Cost of Investment}) \div (\text{Cost of Investment})$$

Technology investment

- ❑ **Before** the owner and CM can accurately **calculate** a **potential** investment's ROI, the CM must **determine how the technology** will benefit the team (lower cost, less risk, etc.).
- ❑ The CM should **develop** a monetary estimate of the owner's potential gains to the schedule, risk contingencies, etc.

How to calculate the cost of technology investment?

Technology investment

- ❑ The CM and owner must also understand the **total cost of investment** (i.e., the total cost of ownership for a piece of technology).
- ❑ Many factors can influence the **cost of a technology investment**, including:
 - ❖ Licensing fees;
 - ❖ Technical support fees;
 - ❖ Installation costs;
 - ❖ Subscription fees;
 - ❖ Training costs;
 - ❖ Risks and claims that technology can create; and
 - ❖ Non-monetary costs (staff time, implementation, etc.).

- ❑ The CM **helps** the owner **determine** these costs to understand a technology's ROI better.
- ❑ The CM should help the **owner define** a minimum acceptable ROI to determine if a technology is financially feasible.
 - ❖ However, the CM should also recognize **when it may be necessary** to **use a different method** to measure a technology investment.

There is also another factor!

Technology investment

- ❑ **Return on value (ROV)** is a separate concept that is more qualitative than **ROI**.
 - ❖ ROV assesses how well a technology achieves the owner's business goals (and the CM's, if separate from the owner).
 - ❖ ROV is more subjective than ROI and varies depending on the owner's needs.
 - ❖ **ROV examples** include
end users' satisfaction and consistency of project/program delivery.

When CM should consider ROV?

Technology investment

- ❑ The CM may need to consider ROV **when** an investment's **ROI does not measure** the full benefit.
 - ❖ ROV may be helpful if an investment has **non-monetary benefits**.
 - ✓ *For example, if a technology helps the team deliver a better quality finished facility to the owner,*
it may be difficult to estimate the financial gains the owner receives from the improved quality.
- ❑ The **owner** may receive **other benefits** during design, construction, and operation which are challenging to quantify,
such as increased satisfaction among the **owner's customers**.

What if the CM is separate from the owner?

- ❑ Note that if the **CM is separate** from the owner and the CM **provides** their own proprietary technology services, the owner may consider the **ROI or ROV** of the **CM's services** in the CM selection process.

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- ☐ The CM must consider a **potential technology's** ethical implications.
- ☐ All technology can be used for **good or bad**,
so the CM must realize that their **decisions impact all levels** within the industry.
- ☐ A CM must help establish clear guidelines and a strong workplace culture that considers a technology's full impact.



- ❑ Many technologies can **improve efficiency** but also present potential privacy and safety concerns.
 - ❖ For example, **digital sensors** in personal protective equipment can track **workers' health and safety** on the jobsite in real-time.
- ❑ These tools can **enhance delivery**,
but they can also give **detailed information** to
CM, the owner, insurance carriers, regulatory agencies, and other
stakeholders
about **how workers spend** every moment of their day.
- ❑ This detailed information also creates **new potential claims risks** for the owner.

- ☐ Therefore, the CM should **implement** checks and balances for how the team will use **each piece** of technology.
- ☐ If a technology could be **misused**,
then the **team** and the **contract documents** must have strong policies and
procedures to **prevent abuse**.
- ☐ All team members should **understand these rules**.

❑ These **checks and balances** must define

❖ **Technology's purpose** on the project/program and

❖ **How the team** will **protect** sensitive data.

✓ *For example, if a technology identifies a **team member's mistake**,
the team's policies and procedures must explain*

o **Who will have access** to that data and

o **How the team will use** this information to

1. *Teach the team member or*

2. *Punish the team member*

3. *(or both).*

- ❑ Note, creating checks and balances does **not guarantee** that a technology is a **good investment**.
- ❑ The CM should consider **ethical checks and balances** as part of a **technology's cost of ownership**.
- ❑ Checks and balances that are **costly or hurt** the team's performance might **cancel out** a technology's **potential benefits**.
 - ❖ *For example, technology may present a **possible opportunity** (e.g., reduce risk, increase sustainability/ resiliency, etc.)*
*but require checks and balances that **limit a team's efficiency** (e.g., require hiring extra staff, hurt morale, etc.).*



مدیریت فناوری‌های دیجیتال در صنعت ساخت (بر اساس سندی از انجمن مدیریت ساخت آمریکا (CMAA))

فصل دوم: فرآیند استاندارد برای مدیریت فناوری‌های دیجیتال در پروژه

بخش دوم: به کارگیری فناوری‌های دیجیتال در مرحله قبل از طراحی

ارائه دهنده:

سید محمدرضا علوی پور

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- ☐ Introduction
- ☐ Clarifying owner expectations and objectives
- ☐ Technology and delivery methods
- ☐ Selecting the design team
- ☐ Management information system
- ☐ Other digital systems
- ☐ Pre-design data
- ☐ Pre-design conference

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INTRODUCTION

Technology in pre-design phase

- ❑ The pre-design phase's goal is to
 - ❖ **Establish** the owner's technology requirements,
 - ❖ **Initiate** overall coordination, and
 - ❖ **Select** the design team.

What should be established here?

Owner primary requirements

- ☐ The owner must **establish** any specific technology requirements as early as possible.
- ☐ The **owner's COS** must define
 - ❖ Technology's role in the scope of work,
 - ❖ Team's responsibilities,
 - ❖ Implementation phases,
 - ❖ Expected outcomes.
- ☐ If using BIM, all **BIM requirements** are also set as early as possible.

How the CM helps the owner at this stage?

- ❑ The CM helps the owner **translate** their **technology goals** into **realistic and tangible** requirements during pre-design and design.
- ❑ The CM does **not need** to be a **technology expert**, but the CM must **understand** the owner's technology requirements well enough to manage delivery.
- ❑ The CM **ensures** that **all contracts** define common terminology and expectations so that all stakeholders **consistently** refer to the **same technology**.

CM in design and pre-design

❑ During pre-design and design,

the CM also **looks** for opportunities to use technology
to **increase** efficiency and add value.

❖ However, the CM must recognize that **new technologies** may

1. Come with significant risks and
2. Involve requirements

that are **unfamiliar** to some owners, designers, contractors, and consultants.

So, what the CM should do?

- ❑ The CM **ensures** that the **owner understands** the implications of **any technology** that the project or program **will use**,

including

1. Technology's appropriate use and
2. Any limitations.

How to do this?

CLARIFYING OWNER EXPECTATIONS AND OBJECTIVES

Owner's technology needs

- ❑ To **understand** the owner's technology needs,
the CM must **first meet** with the owner to
clarify the owner's objectives and expectations, including
owner's expectations for
 1. Cm's services, designer(s),
 2. Contractor(s), and
 3. Commissioning agent (if applicable).
- ❑ The CM should **also clarify** how the project or program
fits into the owner's portfolio.

❑ The CM must then look for opportunities to use technology that will increase efficiency and add value,

but the CM also understands that the newest technology **may not** be the most appropriate.

❖ The CM must carefully **evaluate**

1. Owner's comfort with technology,
2. Potential ROI/ROV, and
3. **How** a technology could be used for good or bad (see previous section).

The CM assists with what at this stage?

❑ The CM assists with

1. Preliminary feasibility and
2. Design studies

to help determine the **technology requirements** (as well as requirements for cost, time, quality, etc.).

❑ Then, a CM **advises** the owner on the most appropriate technology requirements, including the

1. best uses,
2. implications, and
3. shortcomings.

What these conversations aim to between owner and CM?

- ❑ These conversations aim to create a **realistic COS document** that defines the **owner's tangible** technology requirements.
 - ❖ The COS should **complement** the owner's (and CM's, if separate from the owner) **technology charter**, if applicable.
- ❑ If needed and **within** the CM's scope of services, the CM may **advise the owner** to
 1. **Create** a technology charter and
 2. **Manage** the selection of qualified consultants to develop the charter.

- ❑ **After** the CM helps the owner **establish** the **COS**,
the CM **ensures** that all contracts include the **COS** to align the team's goals.

- ❑ If the team uses BIM,
all **design contracts** must also reference the BEP.

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- ❑ The CM also develops the PMP or PgMP, which
 1. **References** the owner's **COS** and
 2. **Establishes** the team's scope, budget, schedule, environmental conditions, methods and procedures, and basic systems,
including **which technology** the team will use throughout **all phases**.

What if the CM joins later?

PMP or PgMP in technology

- ❑ If the CM joins the team in a **later phase** and the **team has already created** these controlling documents, the **CM must still confirm** that the PMP/PgMP and other controlling documents complement each other.

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TECHNOLOGY AND DELIVERY METHODS

The importance of delivery method in technology success

- ❑ **Technology** is an important **component** of **all delivery methods**,
but the CM must **recognize** that in **some** delivery methods
it becomes **more difficult** to incorporate technology in later phases.
- ❑ The CM must help the owner carefully **evaluate** each delivery method,
including how each method may help meet the **owner's technology requirements**.
- ❑ The CM should **advise** the owner that the **different stakeholders** may all have **separate systems** with unique protocols, definitions, and standards.

Generally, the **more entities** involved, the **more complex integration** becomes.

Let's see an example!

The importance of delivery method in technology success

- ❑ For example, **systems integration** is more straightforward
with **collaborative contracts** where participants have **more than one role**.
- ❖ Incorporating **new technologies** throughout the design and construction phases is easier in CMAR
because the **CM** is also the **general contractor/builder**.
- ❖ Design-build contracts allow **direct collaboration** between the design team and general contractor
because they are **both the same entity**.

How about DBB method?

The importance of delivery method in technology success

- ❑ Meanwhile, **design-bid-build** teams face **more risk** when integrating **new technologies**.
- ❑ The CM, designer, and general contractor are **separate entities**, increasing **technology's complexity**.
- ❑ This **complexity grows in later phases** when **new stakeholders** (trade partners, commissioning agents, etc.) join the team.

How the CM helps?

- ❑ However, the CM **helps** design-bid-build teams **mitigate** some of these risks.
- ❑ With the CM's **support**,
the **owner establishes** all technology **requirements** as **early** as possible
so that the team
 1. Has the **most time** to prepare and
 2. **Reduces** the likelihood of changes.
- ❑ The CM should also recommend **risk resolution strategies**,
such as the owner allocating extra budget and schedule contingency
in case the team encounters unexpected problems in **later phases**.

SELECTING THE DESIGN TEAM

- ❑ An **advantage** of the owner selecting a CM **early** on (or having a CM on staff) is that the CM may help the owner **choose a designer**,
if a **separate design contract** is necessary.

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1. Request for proposals (RFP) or request for qualifications (RFQ) and
2. Criteria to evaluate proposals/qualifications.

Then, the CM **advertises** the project/program to the design community.

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- ❑ The **design bid documents** should include the owner's technology requirements.
 - ❖ For example, if the PMP/PgMP requires **BIM**,
the CM includes BIM experience in the RFP's/RFQ's **design team selection criteria**.
 - ✓ The owner and CM should **then evaluate** the design teams' BIM capabilities
during the review and interview process.

- ☐ The team must follow the **owner's required** selection process.
- ☐ Some owners may require the CM to **advertise** the project/program in certain online databases.
- ☐ The **owner** may also use **digital systems** to
 - ❖ Prequalify bidders,
 - ❖ Review proposals,
 - ❖ Negotiate with bidders, and
 - ❖ Award contracts.
- ☐ The CM **ensures** that the team understands and follows these **requirements**.

☐ The CM **works** with the **owner's legal counsel**

to develop the design team contract,

which includes **appropriate language** for technology use.

What should be included in the contract?

- ❑ The contract must address the following:
 - ❖ The owner's design requirements/COS;
 - ❖ BIM requirements, if applicable (BIM model format, allowable use of 2D detailing/LOD, model sharing procedures, etc.);
 - ❖ Pay application processing and review;
 - ❖ Tools and methods for as-built documentation (photography, laser scanning, etc.);
 - ❖ Documentation procedures so that the owner has continued access to design documents after closeout;
 - ❖ Standards for record communications (email, video conferencing, etc.); and
 - ❖ Protocols for document control and distribution (issue logs, meeting minutes, progress reports, procedures for accessing and editing BIM models, etc.).

MANAGEMENT INFORMATION SYSTEM

- ❑ During **pre-design**, the CM should **establish** the MIS that will **inform** the team of the overall status and forecast compared to the established PMP/PgMP.
- ❑ An **effective digital MIS** provides robust **document management** capabilities to
 - ❖ Monitor costs,
 - ❖ Administer contracts, and
 - ❖ View change orders and other documents instantlyusing **connected mobile devices**, which is especially important when onsite.
 - ✓ This document management also includes **design data**, so it is crucial to **develop** the MIS before design begins.

What is the function of MIS?

- ❑ Job and executive-level activity **reports** are a **primary function** of this system.
- ❑ The **MIS** must **provide**
a comprehensive, documented account of **project/program activities** that
executives can review quickly.

What should the CM determine?

❑ The **CM** should **consult** with the owner and the design professional's staff to determine

- ❖ Type,
- ❖ Format, and
- ❖ Frequency

of the **information** and **reports** that the MIS will issue.

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☐ Notifications must include

- ❖ Schedule and progress reporting,
- ❖ Drawing schedules,
- ❖ Budget versus the cost of services, and
- ❖ Change requests (approved and pending)
for design and CM services.

When the first report should be issued?

- ☐ The **MIS** should issue the **first reports** during the design phase and **continue** for the **rest** of the project/program on an agreed frequency

MIS and PMP/PgMP/CMP?

MIS and PMP/PgMP/CMP

- ❑ The PMP/PgMP or CMP may explain the **MIS**,
but large or complex projects/programs may require the **CM to draft a**
separate document
that outlines the **MIS's scope and use**,
depending on the **CM's scope** of services.

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OTHER DIGITAL SYSTEMS

❑ **Many systems** exist in the marketplace that can

- ❖ Enhance the team's performance,
- ❖ Simplify tasks, and
- ❖ Increase efficiency

throughout **all phases**.

❑ This “**off-the-shelf**” **software** is commercially available, scalable, and usually integrates with other systems (such as a digital MIS).

❑ **Deploying** these tools during pre-design can help the team **better manage** the design process.

- ❖ *Examples include, but are not limited to, predictive analytics (AI/BI tools), commissioning platforms, and risk management tools.*

PRE-DESIGN DATA

- ❑ The CM should **review** the data in the team's CDE and anything else provided to the **design team** to ensure that it is as **complete as possible** at this stage.
- ❑ The CM **confirms** that the designers know about any **projector program-specific issues** that the team must evaluate.
 - ❖ Examples of pre-design data may include
 - ✓ Basis of design (BOD),
 - ✓ Preliminary studies such as geotechnical reports, and
 - ✓ The owner's component configurations or material specifications.

PRE-DESIGN CONFERENCE

☐ Before design begins,

the CM

1. Plans,
2. Conducts, and
3. Documents

a pre-design conference that includes

1. Owner and
2. Design team.

What should be addressed in the meeting?

☐ This meeting should address

1. The PMP's/PgMP's design phase considerations,
2. The owner's COS, and
3. The BEP (if using BIM).

☐ The pre-design conference

1. **Defines the technology standards** the team will use during the **design phase** and
2. **Achieves commitment** to the owner's technology requirements (as well as time, cost, quality, etc.)
from all participants.

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دفتر آموزش



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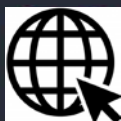
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info@dralavipour.com



www.dralavipour.com



@alavipour_pm



@acemi_social



@alavipour_pm



@IRANACEMI

