

DIGITAL
CONSTRUCTION
SUMMER SCHOOL

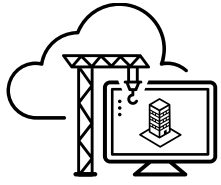
Developing BIM Talent: A Guide to the BIM Body of Knowledge with Metrics, KSAs, and Learning Outcomes

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Raja R. A. Issa, Dana K. Smith



AUTODESK.





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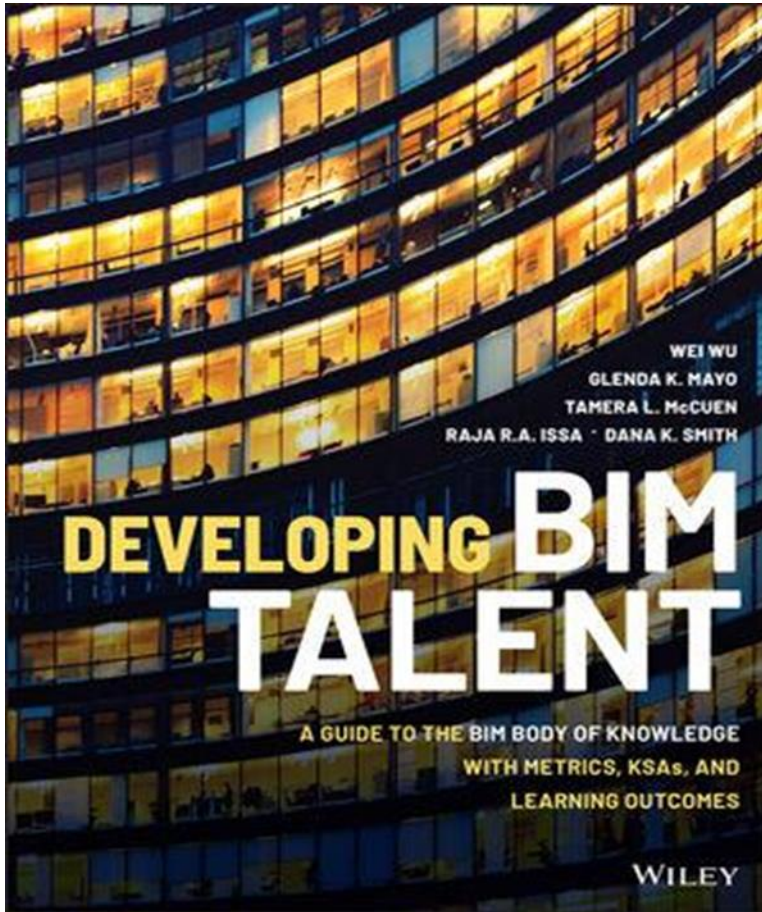
Developing BIM Talent: A Guide to the BIM Body of Knowledge with Metrics, KSAs, and Learning Outcomes

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- US Department of Defense – 30 Years
- National Institute of Building Sciences – 30 Years
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 - 8 Years on Staff After DoD Retirement
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Table of Contents



- Chapter 1: Call for a BM BOK
- Chapter 2: BIM BOK Development
- Chapter 3: BIM Education and Talent Procurement
- Chapter 4: BOK-Informed BIM Instruction
- Chapter 5: BIM BOK-Informed Workforce Planning and Development
- Chapter 6: Future of BIM BOK

Key Goals

- **Must Provide BIM Education and Training a Common Foundation**
 - A Focal Point For Entire AECOO Life Cycle
- **Current Education and Training Needs To Be Connected**
 - Between Colleges at a University
 - Between Universities
 - Between Disciplines
 - Between Countries
- **We Need A Strong Life Cycle View**
 - Need to develop “T” Shaped Learners and Practitioners
- **Need Coordinated Credentialing Opportunities**
 - Mostly Discipline Focused – unmanaged, the number will grow exponentially!

Foundation - Bloom's Taxonomy

	Verbs			
Level	Factual	Conceptual	Procedural	Metacognitive
Creating	Generate, Write, Combine	Gather, Devise, Plan	Design, Develop, Compose	Produce, Create, Actualize
Evaluating	Check, Criticize, Rank	Define, Review, Assess	Judge, Evaluate, Conclude	Reflect, Rate, Prioritize
Analyzing	Choose, Classify, Order	Distinguish, Identify, Explain	Integrate, Compare, Differentiate	Match, Analyze, Achieve
Applying	Use, Answer, Classify	Give, Set, Experiment	Carry Out, Employ, Calculate	Select, Enhance, Construct
Understanding	Interpret, Categorize, Summarize	Categorize, Describe, Consider	Paraphrase, Clarify, Predict	Foresee, Explain, Execute
Remembering	Label, Spell, List	Recognize, Name, Describe	Recall, Recap, Tabulate	Outline, Identify, Omit

Chapter 1

Historical context
and big picture
view

How the
implementation of
BIM is progressing

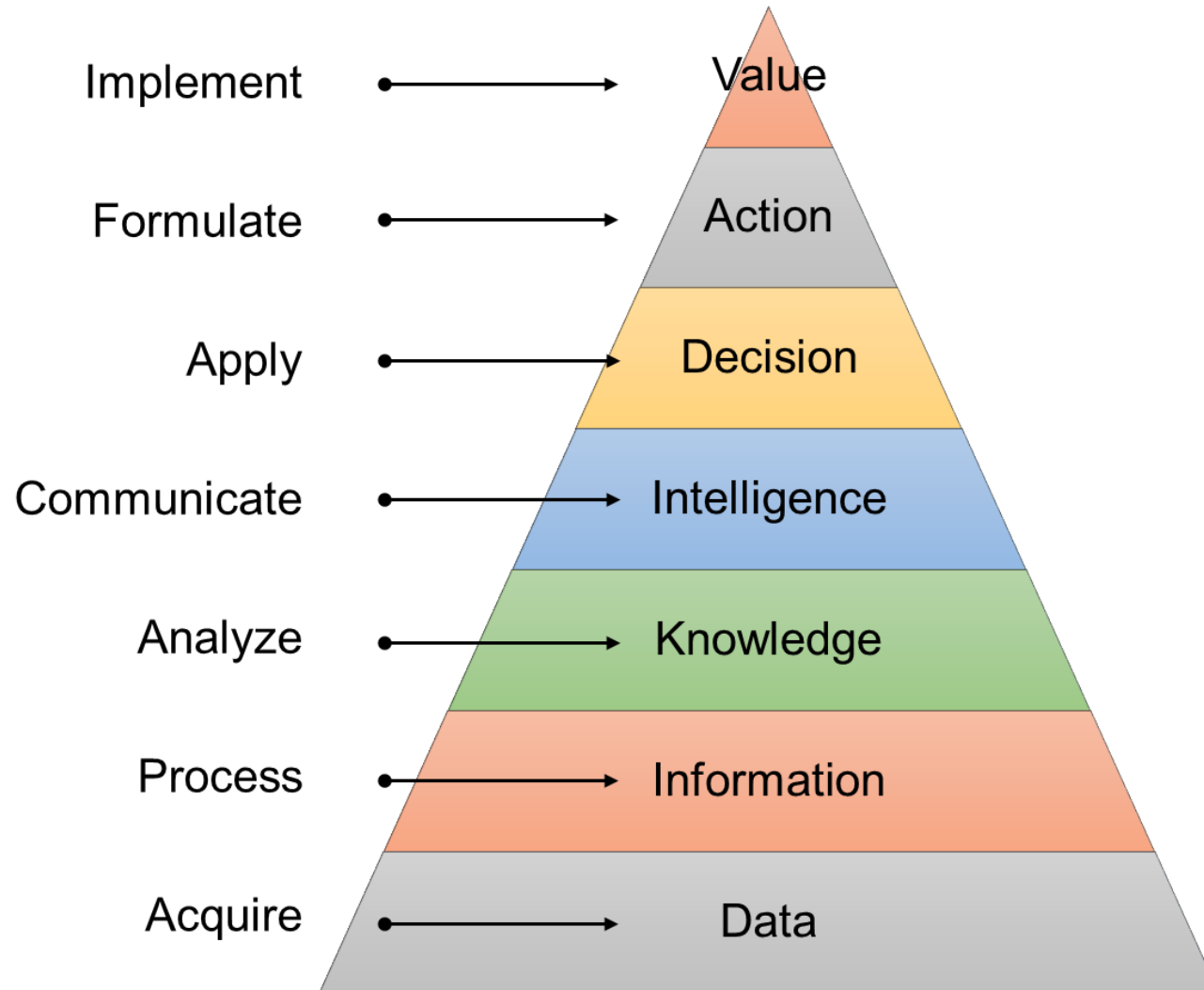
Call for a **BIM BOK**

State-of-the-art
BIM case studies

How AiC arrived at
the point of
developing the BIM
BOK.



Data Information Knowledge Wisdom Hierarchy



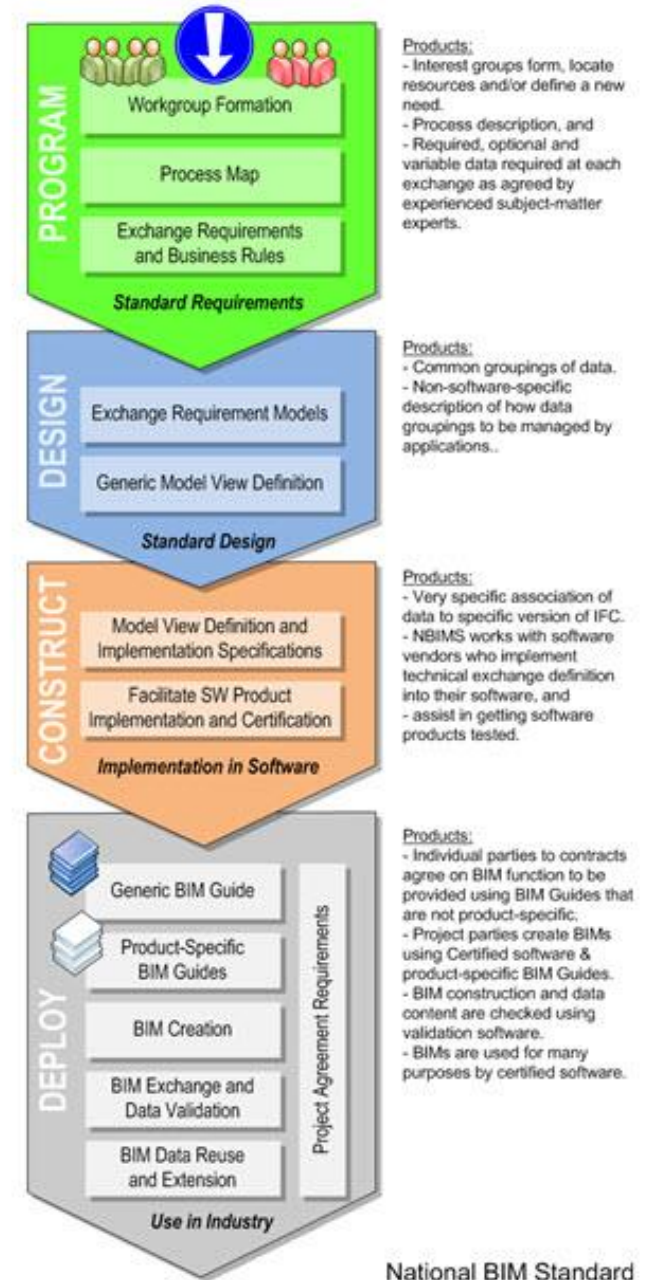
Source: Adapted from Frické (2008) and Powell (2020)

**The Value Of
Data Is Not
Realized Until It
Is Implemented**

BIM BOK / Use Case Relationship

	Design						Construction						Facility Manager						Consultant Generalist					
	Entry Level		Mid Level		Full Performance		Entry Level		Mid Level		Full Performance		Entry Level		Mid Level		Full Performance		Entry Level		Mid Level		Full Performance	
	Organizational		Project		Organizational		Project		Organizational		Project		Organizational		Project		Organizational		Project		Organizational		Project	
Plan It																								
Coordinate It																								
Manage It																								
Do It																								

Source: Deke Smith



National BIM Standard
Interoperable Exchange Development and Use

Version 1.0 - © NIBS 2007

Chapter 2

BIM BOK Development

Define BIM BOK

Educational
learning objectives
of BIM

BIM BOK
framework and
consensus-based
development

Develop Job Tasks
and associated
KSAs



Develop the BIM BOK

Delphi Panel Selection

- Demographics & Qualification Survey
- Non-Disclosure Agreement

Round 1

- Brainstorming
- Relevance Checking
- Confirmed BIM BOK Line Items

Round 2

- Rating & Consensus Evaluation
- Early Consensus & Early Strong Agreement

Round 3

- Re-rating & Re-evaluation
- Final Levels of Agreement

Candidate list of BIM BOK contents

Plan It (27)

- Organizational mission statement
- BXP: Process mapping
- BXP: Information exchange
- BXP: Goals
- BXP: BIM usage
- BXP: Procurement strategy
- ISO 15686-10: Life cycle functional performance
- Infrastructure planning
- Quality assurance effort
- Business process mapping
- Employer information requirements
- Benchmarking practices
- Security policy
- Risk management
- Facility management needs
- Enterprise architecture
- Life cycle assessment
- Organizational training of others
- Develop guides
- Building performance targets
- Commissioning plan
- Staffing projects
- Budget (VDC/BIM)
- Software selection & upgrade strategy

Coordinate It (6)

- Technical support for interoperability
- Model coordination
- Pre-construction issue resolution
- Software version coordination
- Providing training
- Understand the roles of all phases of the life cycle

Manage It (21)

- Model quality control
- Manage BXP
- Refine BXP
- Performance measurement
- Model validation
- Standards compliance checking
- Buy-in from stakeholders throughout the organization
- Contract language
- Manage workforce
- Project controls - budgeting/cost
- Project controls - scheduling/time
- Project lifecycle data collection - feedback loop
- Leadership - team building
- Contract administration
- Change management
- Project administration
- Manage information exchange
- Pre-construction issue resolution
- Evaluate metrics
- Protecting IP of digital assets
- Professional ethics

Do It (13)

- Rendering for marketing
- Individual effort
- Understands just your own model
- Ability to build a model
- Aggregate a model
- Software usage
- Solving problems and gaining knowledge
- Estimating
- Site logistics
- List of BIM uses
- Knowledge of scripting
- Knowledge of programming
- Technical writing

List of Abbreviation

BIM: Building Information Modeling
BXP: BIM Execution Planning
IP: Intellectual Property
ISO: International Organization for Standardization
VDC: Virtual Design and Construction

Roles of Users (ROUs)		Designer				Contractor				PMC/Owner				Consultant/Generalist			
Levels of Performance (LOPs)		Entry Level				Middle Level				Full Performance							
Types of Knowledge (TK) (Organizational or Project)		O	P	O	P	O	P	O	P	O	P	O	P	O	P	O	P
TKs		BOK Description				BOK Description				BOK Description				BOK Description			
		Item I				Item II				Item III				Item IV			
1	Organizational mission statement	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	BPM? Process mapping	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3	BPM? Information exchange	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4	BPM? Goals	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5	BPM? BIM usage	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
6	BPM? Procurement strategy	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
7	ISO 15686-10: Life cycle functional performance	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
8	Information unlearning	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
9	Quality assurance effort	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
10	Business process mapping	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
11	Employer information requirements	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
12	Benchmarking practices	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
13	Security policy	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
14	Risk management	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
15	Facility management needs	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
16	Enterprise architecture	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
17	Life cycle assessment	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
18	Corporate/organizational learning	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
19	Organizational training of others	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
20	Professional development	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
21	Internal standards across the organization	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
22	Develop guide	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
23	Building performance targets	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
24	Commissioning plan	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
25	Staffing projects	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
26	Budget (VOC/BIM)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
27	Software selection & upgrade strategy	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
TKs	BOK Description	Organizational I				Organizational II				Organizational III				Organizational IV			
1	Technical support for interoperability	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	Model coordination	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3	Pre-construction issue resolution	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4	Software version coordination	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5	Providing training	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
6	Understand the roles of all phases of the life cycle	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
TKs	BOK Description	Message I				Message II				Message III				Message IV			
1	Model quality control	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	Message BOP	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3	Message BOP	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4	Performance measurement	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5	Model validation	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
6	Standards compliance checking	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
7	Buy-in from stakeholders throughout the organization	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
8	Contract language	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
9	Message workflow	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
10	Project controls - Budgeting/cost	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
11	Project controls - Scheduling/time	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
12	Project life cycle data collection - feedback loop	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
13	Leadership - team building	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
14	Contract administration	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
15	Change management	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
16	Project administration	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
17	Message information exchange	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
18	Pre-construction issue resolution	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
19	Evaluation metrics	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
20	Protecting intellectual property (IP) of digital assets	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
21	Professional ethics	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
TKs	BOK Description	Do it				Do it				Do it				Do it			
1	Handing for marketing	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
2	Individual effort	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
3	Understand just your own model	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4	Ability to build a model	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
5	Aggregate a model	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
6	Software usage	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
7	Solving problems and gaining knowledge	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
8	Estimating	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
9	Site logistics	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
10	List of BIM uses	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
11	Knowledge of scripting	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
12	Knowledge of programming	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
13	Technical writing	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Heat map on median values of importance rating of BIM BOK line items

Perceived importance ratings of BIM BOK line items tend to increase with the LOPs dimension, i.e., from Entry to Middle and then to Full Performance.

Designers tended to give the lowest importance ratings while Consultants/Specialists tended to give the highest.

Chapter 3

BIM Education and Talent Procurement

Historical context and existing practices of BIM education and talent procurement

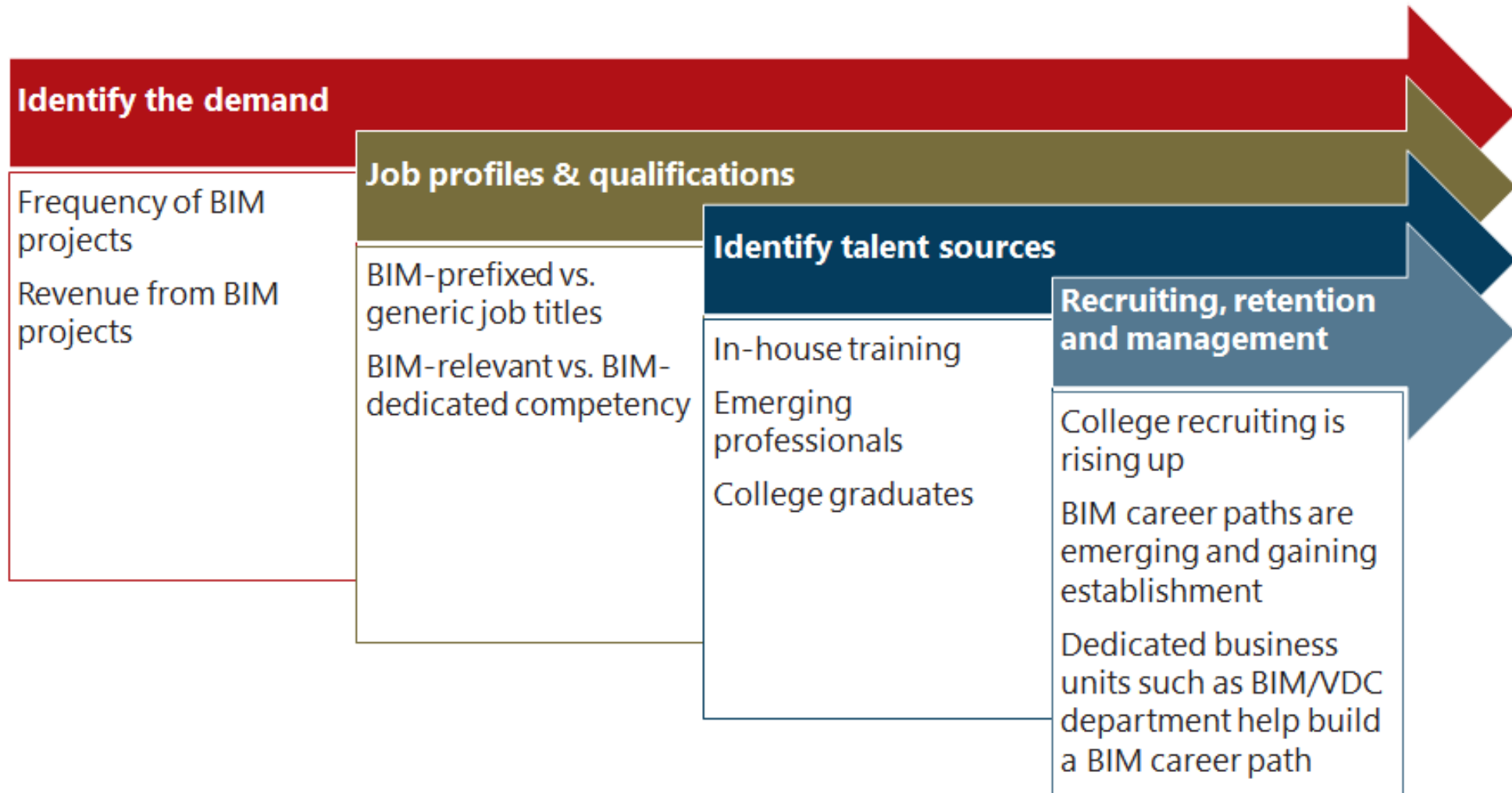
Trends, gaps, and opportunities to improve the status quo with the application of the BIM BOK.

How the implementation of BIM and BIM talent recruitment is progressing

Unified framework for BIM education, training and talent acquisition



BIM Talent Acquisition Process



Chapter 4

Abbreviated literature of BIM
curriculum development &
instructional design

BOK for curriculum
development

BOK-Informed BIM Instruction

BIM pedagogy &
learning activity
design

BOK-informed
learning/training
module design



Module Design Part 1: Context for Instruction



1.1 Course Type



1.2 Total Time for Instruction



1.3 Instructional Strategy



1.4 Learners' Role/Discipline



1.5 Discipline Specific Existing KSAs



1.6 Existing BIM KSAs



1.7 Category of Learning Outcome

Module Design Part 2: Module-Specific Information

2.1 LOP

2.2 BIM Use

2.3 BIM Job
Task

2.4 LOI

2.5 Learning
Goal

2.6 Learning
Objective

2.7 Learning
Outcome - BIM
Knowledge

2.8 Learning
Outcome - BIM
Skills

2.9 Learning
Outcome – BIM
Abilities

2.10
Instructional
Materials

2.11 BIM
Technology

2.12 Practice
Activities

2.13
Assessment
Format

Chapter 5

Historical context of
workforce planning in
AECO industry

Develop a BIM
Workforce
Planning/Succession
Model

BIM BOK-Informed Workforce Planning and Development

BIM workforce
planning case study

BIM BOK-informed
workforce planning:
knowledge, skills and
abilities for job tasks



BOK for BIM Workforce Planning and Development

1

Focus on the Job Tasks and associated Knowledge, Skills and Abilities (KSAs)

2

Look at varied levels of performance (LOPs)

- Entry
- Middle
- Full Performance

3

Look at different roles of users (ROUs) played in the AECO industry

- Designer
- Contractor
- Facility Manager/Operator
- Consultant

Expert interview and validation

Job task and KSAs are validated by industry leaders and experts.

Information captured in these sections were meant to be used by both educators and corporate trainers.

The Job Tasks and KSAs serve as the measures for evaluation of individual's BIM competencies.

For convenience of use, pocket guides are also developed for quick reference.

The BIM BOK **Designer** role was defined as responsible for the development and creation of building and site solutions based on specific knowledge or experience as listed in OmniClass® Table 33-21 Design Disciplines (OmniClass 2006). The BOK Designer role includes architecture, interior design, engineering, and specialty design.

Designer Entry Level of Performance – Tasks and KSAs

Professionals at the entry-level are those who hold a bachelor's degree or equivalent technical education in one or more of the AECO disciplines and is entering their career full-time. It is at this LOP that faculty in higher education and instructors in technical trade schools design instruction and learning activities. *Entry Level* KSAs reflect those that can reasonably be expected from individuals whose level of learning corresponds with remembering and understanding the information associated with a topic.

Job Task	Definition	KSAs
Organizational mission statement	An organizational mission related to building information modeling is an organization's reason for producing building information models. It should reflect the values and beliefs of top managers in an organization and their implementation of building information models. A mission statement is the broad definition of the organizational mission and its use of BIM. It is sometimes referred to as a creed, purpose, or statement of corporate philosophy and values related to their BIM strategy.	Knowledge of the overall organizational mission and how BIM will support that mission. Applications and advantages of BIM for organizations. The values of business values of BIM for organizations. Knowledge of overall organization's function, markets, and competitive advantages and how BIM will support the intended mission and business goals.
		Skills with technical writing. Ability to understand the mission needs and advantages of BIM.
BXP: Information exchange	The BIM Execution Plan (BXP, BEP or BIMXP) is developed by suppliers - typically pre-contract to address the Employer's Information Requirements (EIR) - and defines how the information modeling aspects of a project will be carried out. Information exchanges shall be identified. While the standard is COBie, it is a data schema and therefore each project will be unique as to what information is exchanged between each party. The	Knowledge of BIM execution planning and information exchanges. Various data and information involved in BIM implementation, types of data and formats of data, parties involved in data and information exchange, and interoperability concepts. Knowledge of information exchange standards (both proprietary and open standards) and their applicable contexts.

Chapter 6

What are the next steps?

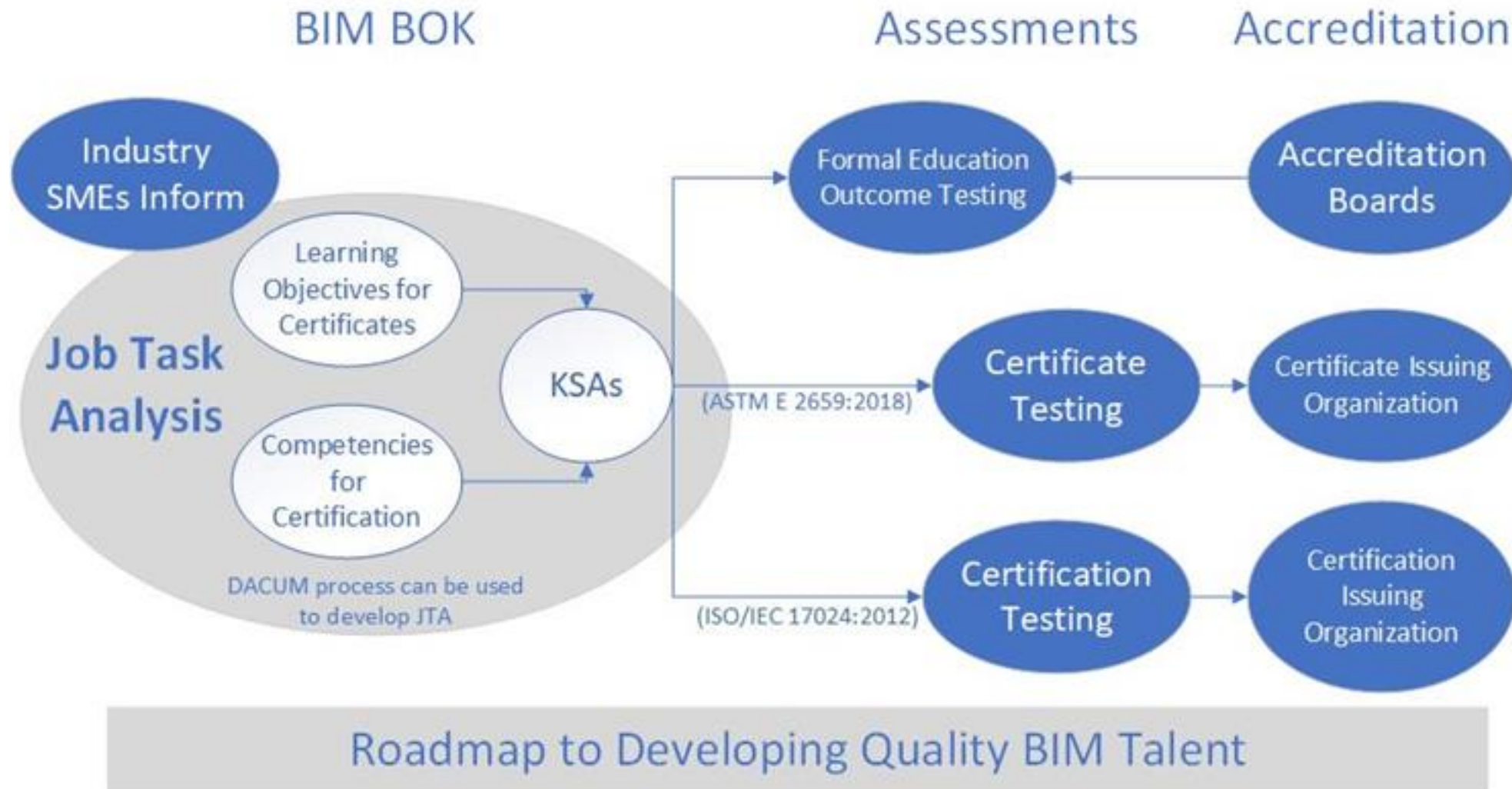
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