Modernization of Uzbekistan Building Code (UBC) System

BIM & Smart Construction

Technologies for Tracking the Construction Process and Problem Identification at the Early Stages of Construction

Lee, Jin Gang

Sunmoon University

국토교통부
Ministry of Land, Infrastructure and Transport

해외건설협회
International Contractors Association of Korea

KICT
한국건설기술연구원

서울시립대학교
UNIVERSITY OF SEOUL

RICON
KOREA RESEARCH INSTITUTE FOR CONSTRUCTION POLICY

Lecturer

이진강 (Lee, Jin Gang)

jinganglee@sunmoon.ac.kr

- **Education**
  - Bachelor, Seoul National University (2007 – 2011)
    Dept. of Architecture and Architecture Engineering
  - Master of Science, Seoul National University (2011 – 2013)
    Construction Engineering and Management Laboratory
    Thesis: BIM based Cost-Schedule Integration using IFC for Building Construction
  - Doctor of Philosophy, Seoul National University (2013 – 2019)
    Construction Engineering and Management Laboratory
    Thesis:Conceptual Estimation of Construction Cost by Neural Network Ensemble Learning incorporating Factor Analysis

- **Experiences**
  - Assistant Professor, Sunmoon University, Division of Architecture (2021 ~ present)
  - Postdoctoral Fellow, The Hong Kong Polytechnic University, Dept. of Building and Real Estate (2019 ~ 2020)
  - Researcher, Seoul National University Institute of Construction and Environmental Engineering (2019)

- **Research Interest & Teaching Area**
  - BIM Applications for Design Collaboration and Construction Management
  - Smart Construction Technologies: Virtual Reality, Augmented Reality, Machine Learning, Computer Vision
  - Construction Management: Schedule, Cost, Safety, Quality

Contents

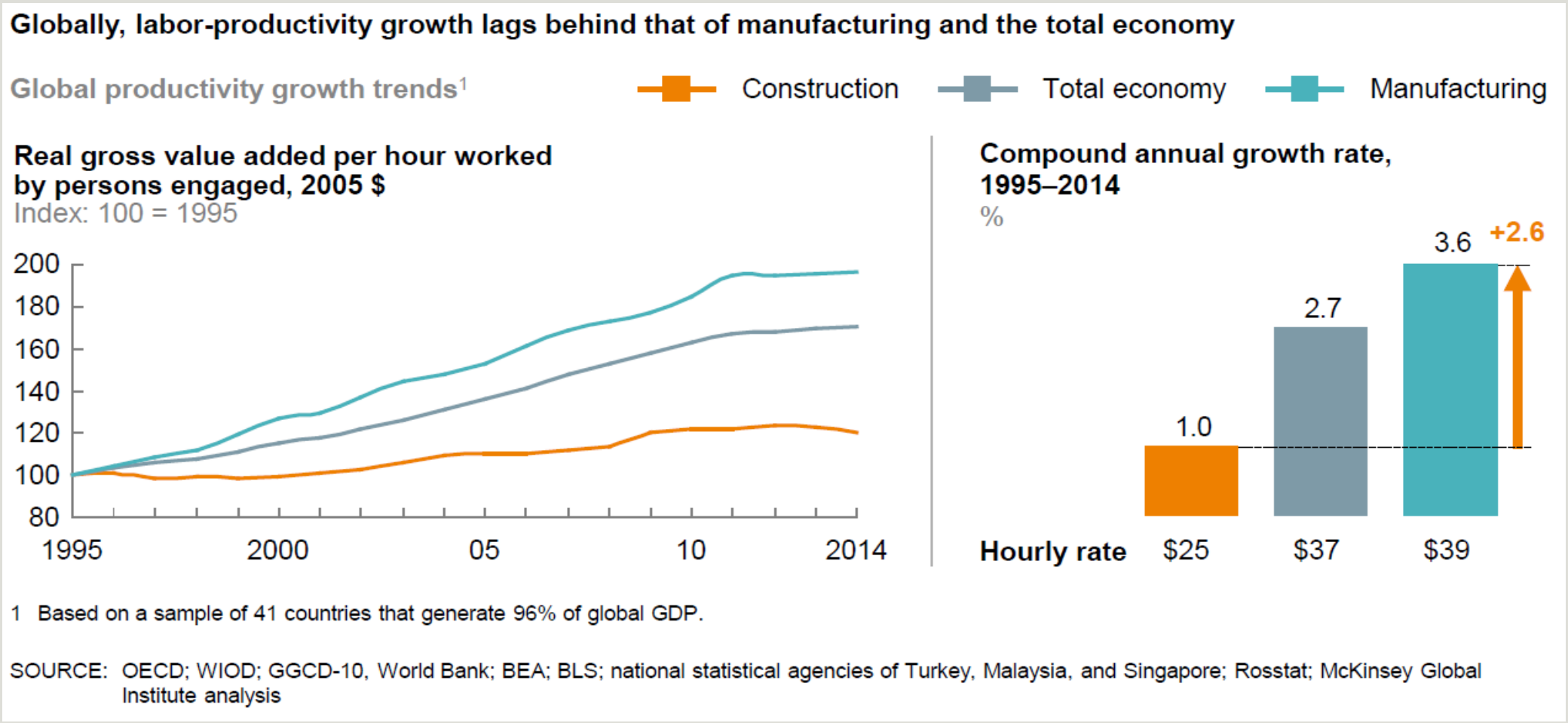
Background

- **Construction Productivity**
  - Empire State Building (New York, 1930)
  - Lotte World Tower (Seoul, 2016)

VS

Background

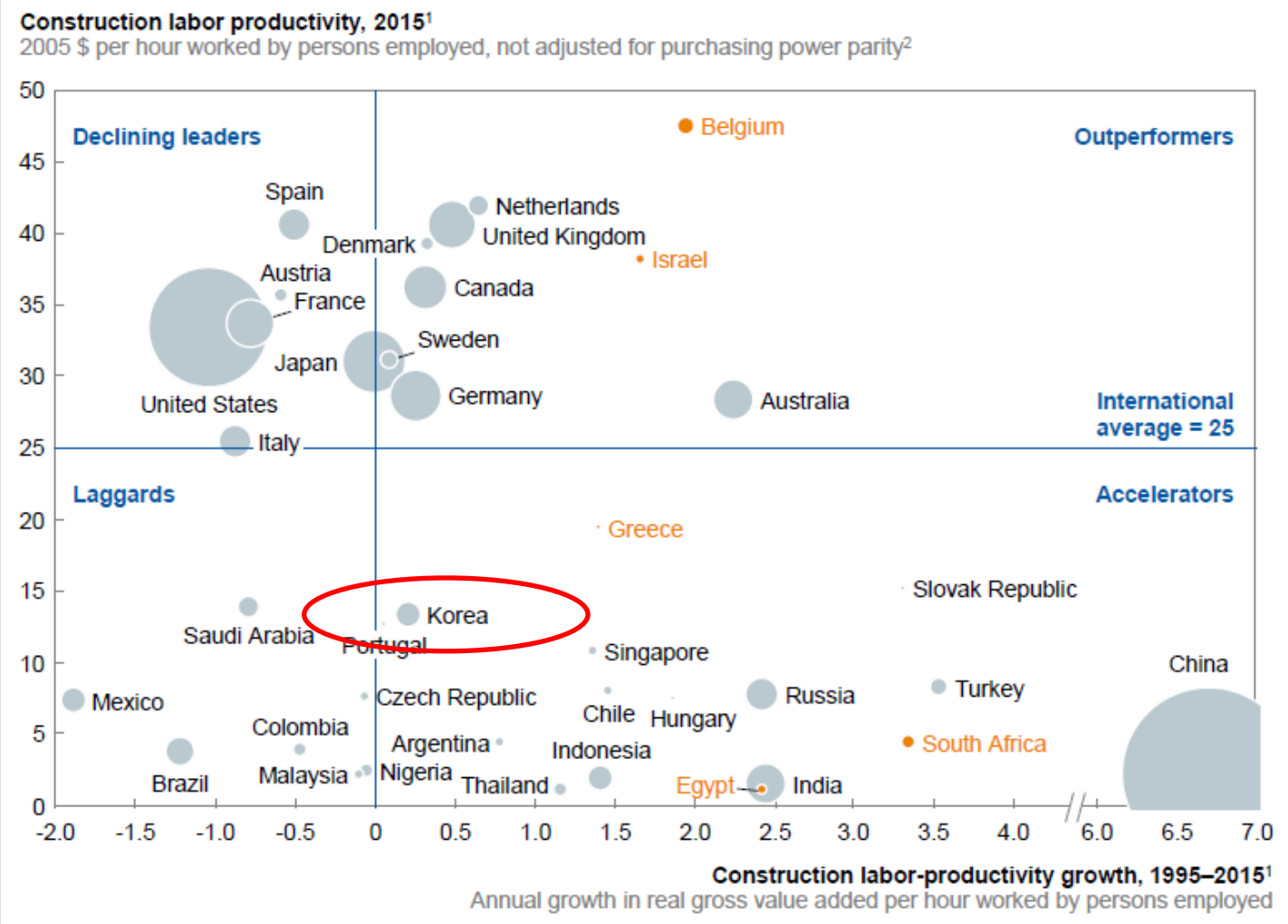
- **Productivity of Construction Industry**
  - The construction industry is known as a typical high cost and low productivity industry.



Reference: Mckensey (2017), Reinventing Construction

Background

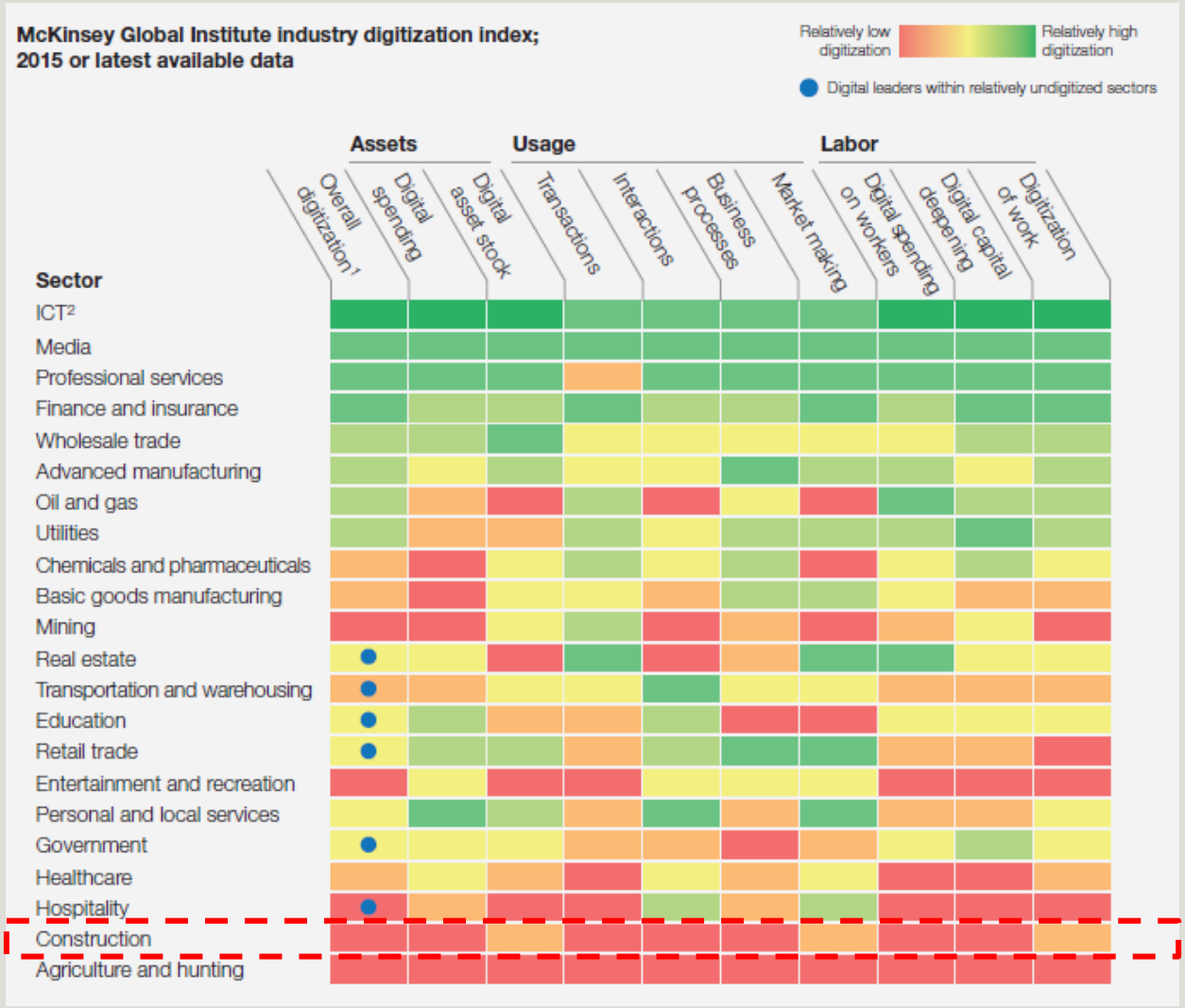
- **Productivity of Construction Industry**
  - The construction industry is known as a typical high cost and low productivity industry.
  - In the case of South Korea, it is growing every year, but it is only half of the global average.



Reference: Mckensey (2017), Reinventing Construction

Background

- **Digitalization of Construction Industry**
  - Contrary to the 4th industrial revolution, the level of digitization in the construction industry is low.
  - Construction industry requires digital transformation.



Reference: Mckensey (2016), Imagining Constructions Digital Future

Building Information Modeling

- **Project Management**
  - Plan / Execute / Manage elements of resources in accordance with project goals to produce the final product of a construction project.

- **Project Information Management**
  - Project information management is to efficiently collect, share, and process information necessary for project planning and management so that it can be used effectively and managed so that it can be used as data for future plans, etc.

Resources: Equipment, Labor, Material

Information: Drawing, Schedule, Cost, Law

Goals: Time, Cost, Quality, Safety

Image Source: https://www.saviom.com/index.php

Building Information Modeling

- **Definition**
  - BIM is the creation and management of information necessary for various decision-making of a construction project in a computer-interpretable form (digital) based on the object of the 3D model (object-oriented).

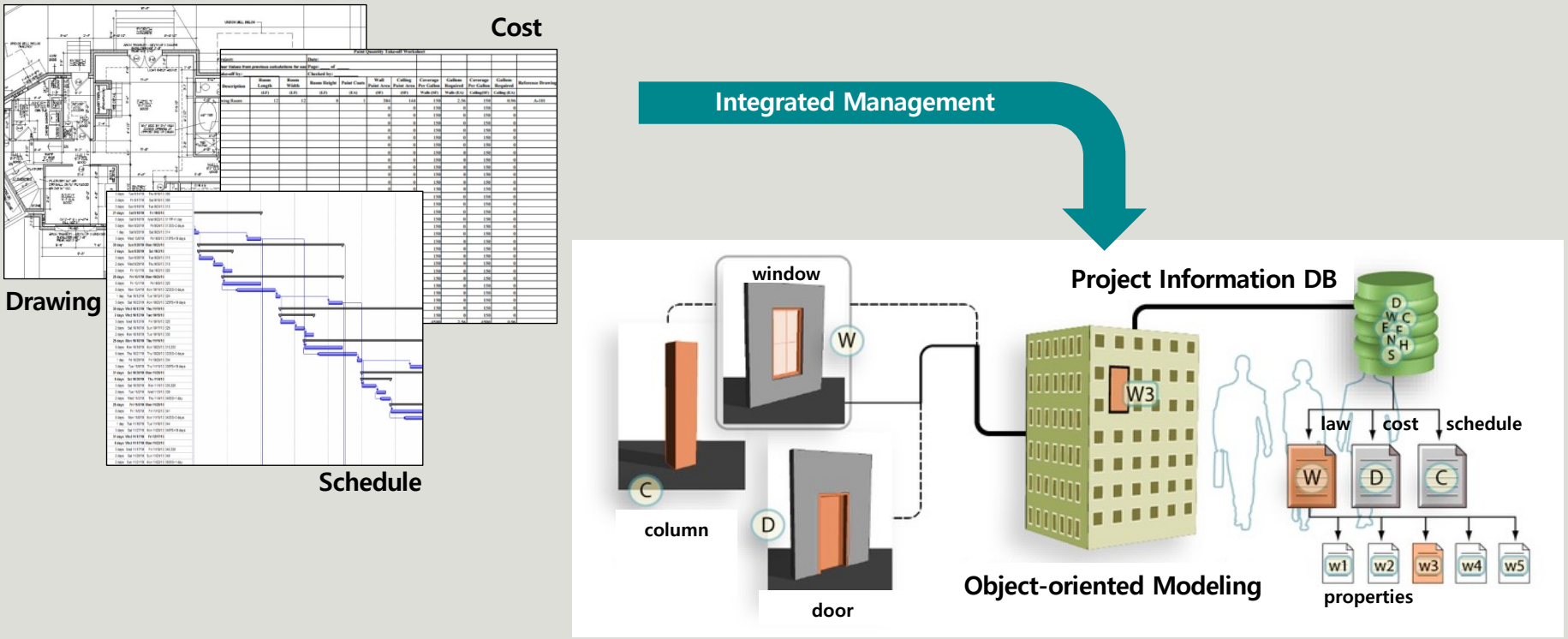
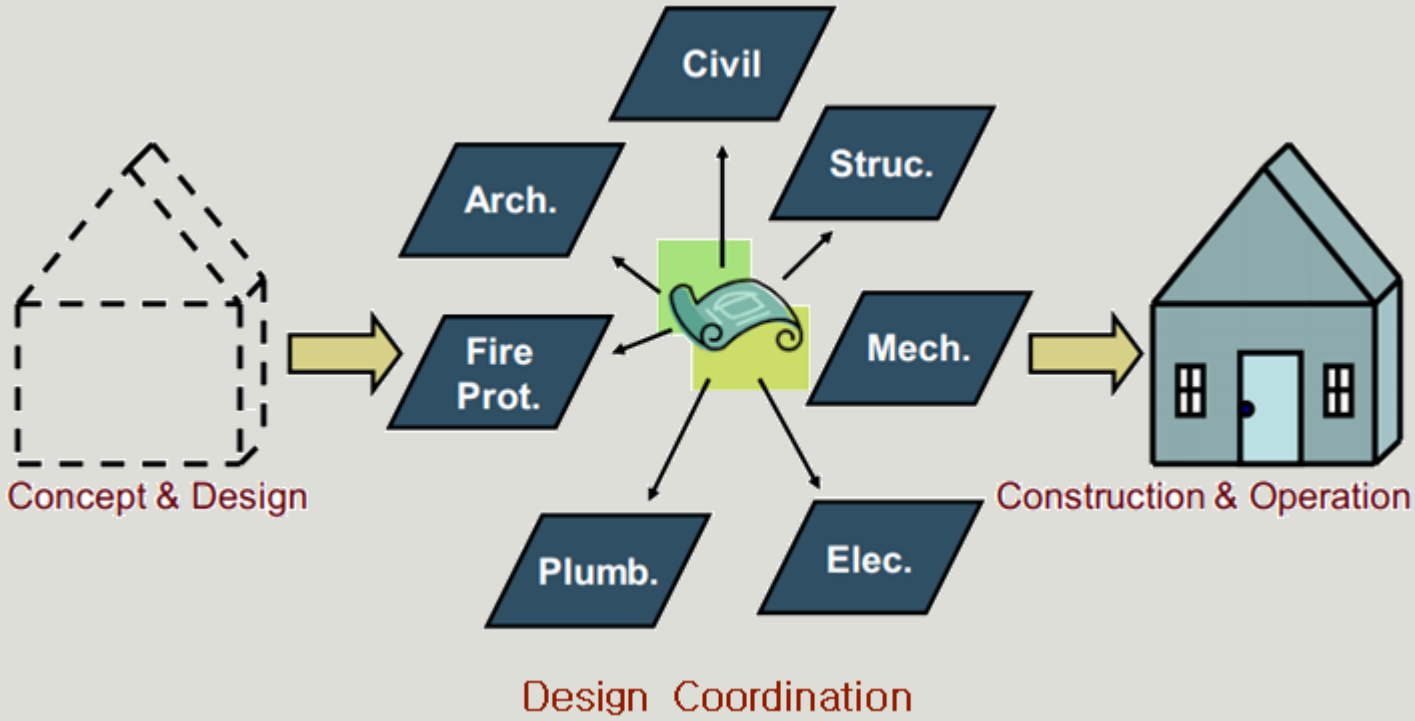


Image Source: Succar, B. (2009); doi:10.1016/j.autcon.2008.10.003

Building Information Modeling

- **Design Coordination / Collaboration**
  - A collaborative process between various specialties such as architecture, structure, MEP, etc..
  - Design collaboration is the process of integrating design proposals from individual specialties.



Building Information Modeling

- **Design Coordination / Collaboration**
  - There are hundreds or thousands of issues to be resolved in the design collaboration process, which consumes considerable time.

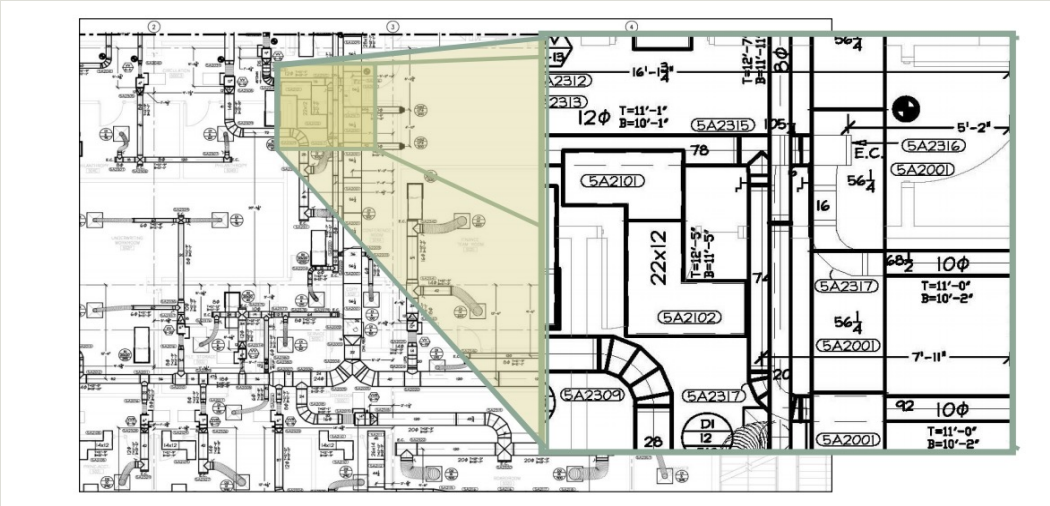
Building Information Modeling

- **3D Visualization**
  - 2D vs 3D

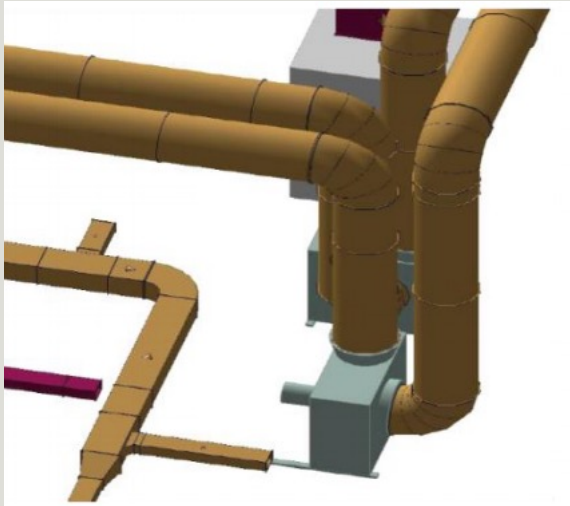
How do you currently coordinate MEP work with 2D drawings?

Building Information Modeling

- **3D Visualization**
  - 2D: Separated, Manual → Error prone, Time-consuming
  - 3D: Integrated, Digital → Effective Communication



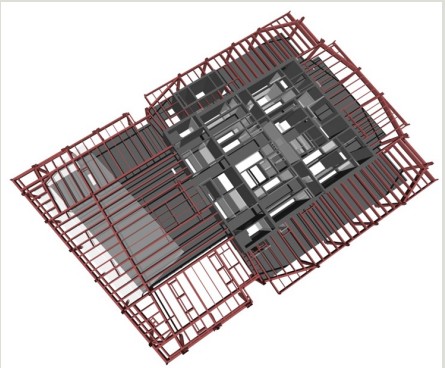
VS



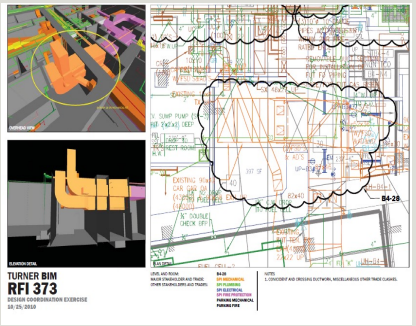
Building Information Modeling

- **3D Visualization**
  - Model-based Design Coordination Process

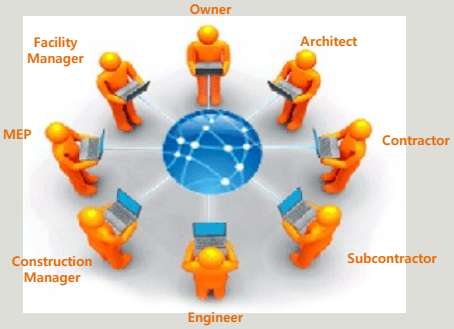
Model Creation → Model Management → Communication



- Create and submit model (BIM authoring tools)



- Analyze the model and identify issues. (BIM analysis tools)
- Create coordination documents
- Add issue related information on model or coordiantion document



- Check information of issues (in both model and document)
- Create coordination documents
- Add issue related information on model or coordiantion document

Building Information Modeling

- **Clash Check**
  - Clash is an unintentional overlap between different objects or too close together so that construction is impossible in that state.

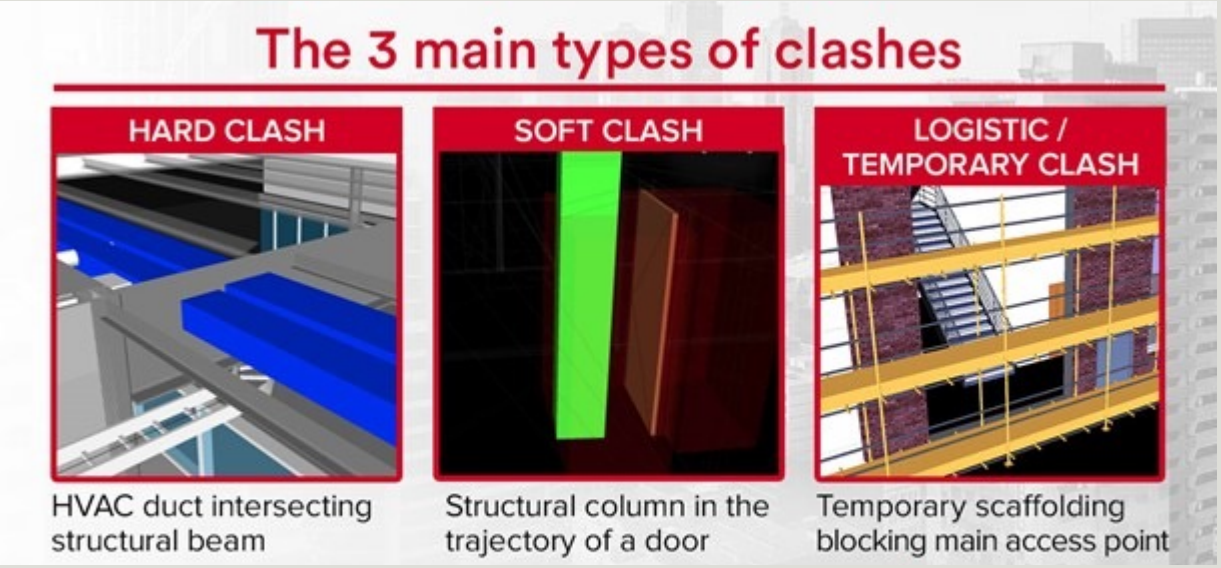


Image Source: https://bimtrack.co/blog/blog-posts/clash-detection-vs-quality-control-the-differences

Building Information Modeling

- **Clash Check**

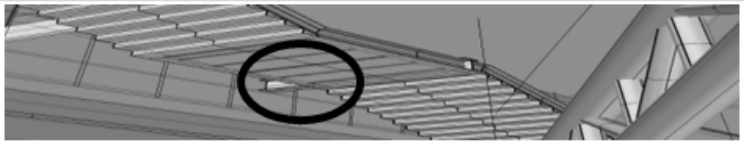
Hard Clash

- Two or more objects exist in the same space.

Request for Information

Project Name : Project001										
Document No. ND001										
Title : Inform clash detection result						**Status**	**Open**	**In Progress**	**Approved**	
								√		
Date:	**Open**	yyyy	mm	dd	**Due**	yyyy	mm	dd		
Author	■ **Architecture**	□ **Structure**	□ **Civil**	□ **Mechanical**	□ **Electronic**	□ **Others**				
Assigned To	□ **Architecture**	■ **Structure**	□ **Civil**	■ **Mechanical**	□ **Electronic**	□ **Others**				

Request Information

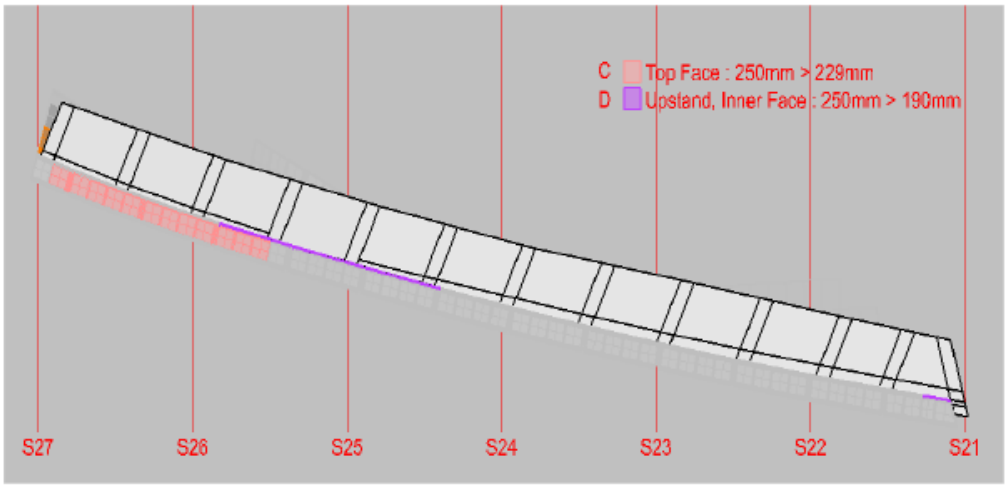
Issue No.		**Contents**
001	**Model Image**	
	Model File	355A_B_LJG_AT_E12_F74US
	Location	Ground Floor AC220
	Comments	Check steel structure connections clash, should be discussed
002	**Model Image**	
	Model File	355A_B_LJG_AT_E12_F74US
	Location	B2 High Level
	Comments	Check steel structure clash with stair panel

Building Information Modeling

- **Clash Check**

Soft Clash

- Two or more objects do not directly overlap, but require the same space.
- Insufficient space between objects causes difficulties in construction or use of buildings on site..



16c - P4 V cladding top surface above concrete upstand

16d - P4 V cladding inner face at concrete upstand

Reg No.	16a,b,c,d		
Clash Name	Concrete structure vs P4 V cladding EWS panels		
Date Found	20120518		
Location	NE_Level 2		
Description	Clearance between concrete structure surface and EWS panel BGLs less than 250mm		
Action	Discussed in Mtg #4	Resoponsible Party	MTR
Status	Pending	DAmS to be issued	
RFI No.	810A-RFI-LGJ-SEB-000116		

Building Information Modeling

- **Clash Check**

  4D / Workflow Clash

  - Depending on the progress or on-site situation, collisions of objects and duplication of required space occur.
  - The movement of temporary works and materials during construction is the main cause of workflow clash.

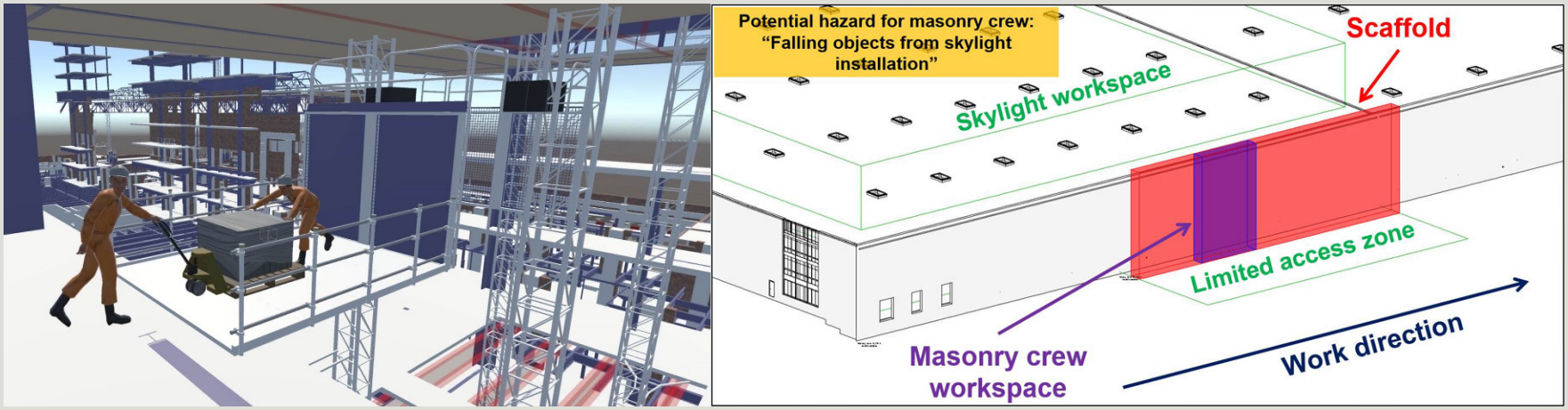


Image Source: Swallow, Mark Richard, and Sam Zulu. "Benefits and Barriers to the Adoption of 4D Modelling for Site Health and Safety Management." Frontiers in Built Environment 4 (2018): 86.

Building Information Modeling

- **4D Simulation**
  - 4D = 3D + Time (referred to as 4D by adding the concept of time to the 3D model).
  - Model the building shape or site situation during construction, which changes every moment.

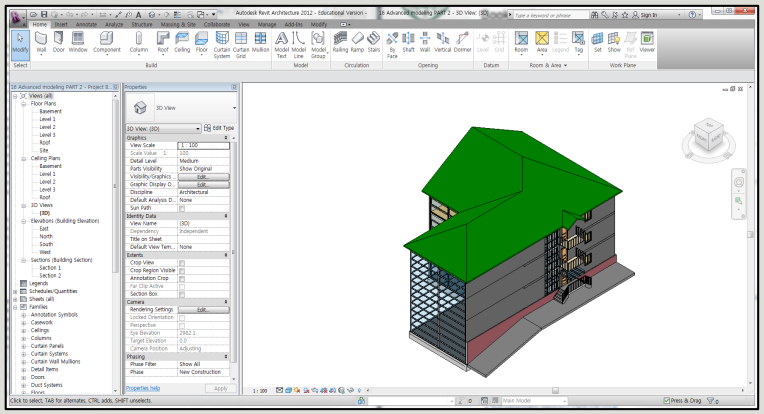
Revit Architecture – Modeling

Navisworks – 4D Sequencing

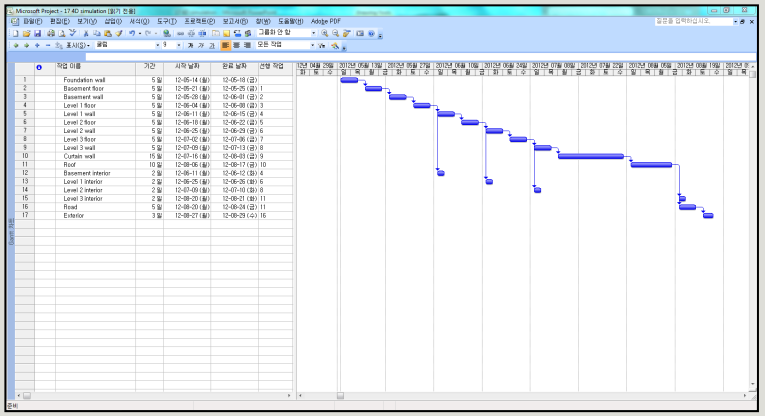
Building Information Modeling

4D Simulation

- Import the activity created in the project management software (Primavera, MS Project)
- Link BIM objects related to each activity.

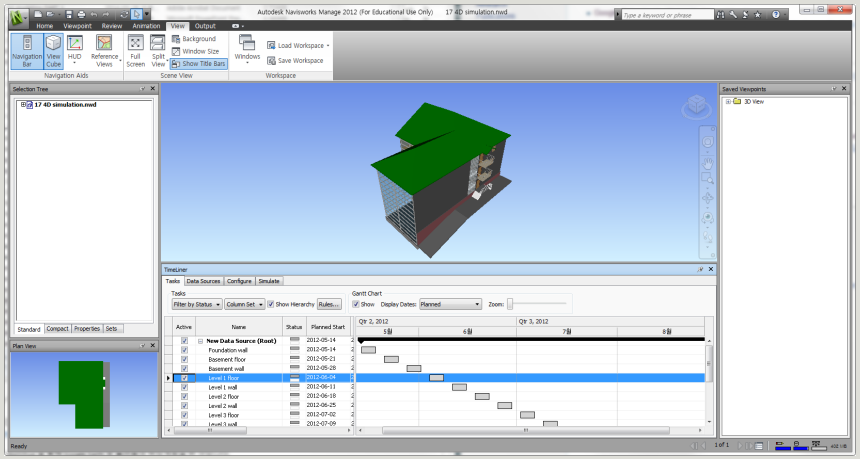


<3D Model (Revit)>



<Project Schedule (e.g., MS Project)>

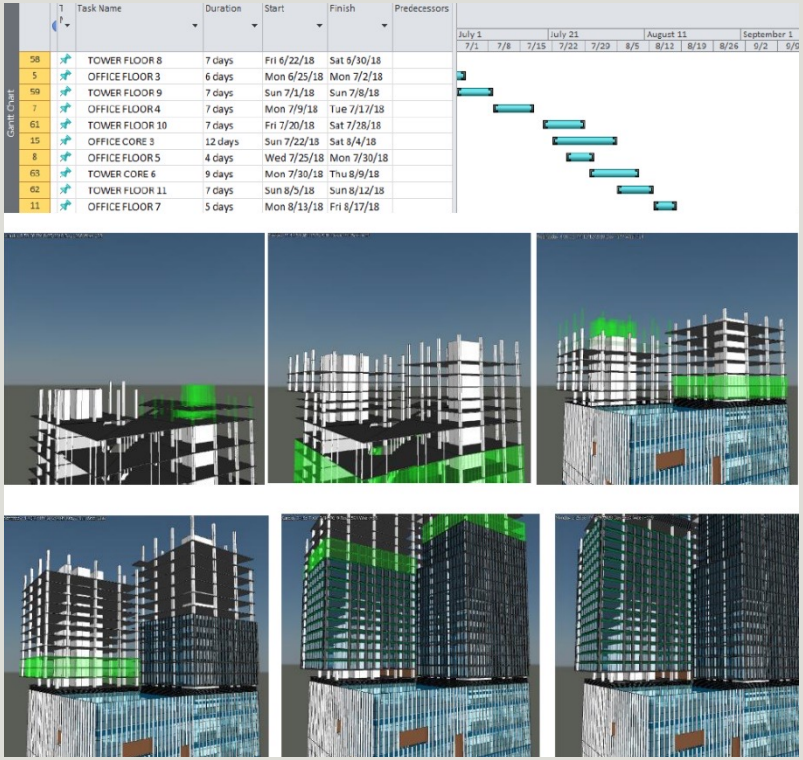
Navisworks Exporter



1) Import a schedule file
2) Create a schedule in Navisworks

Building Information Modeling

- **4D Simulation**
  - Checking the actual construction plan in three-dimensional
  - Analyze the feasibility of the process plan or the retrieval plan in the virtual site.

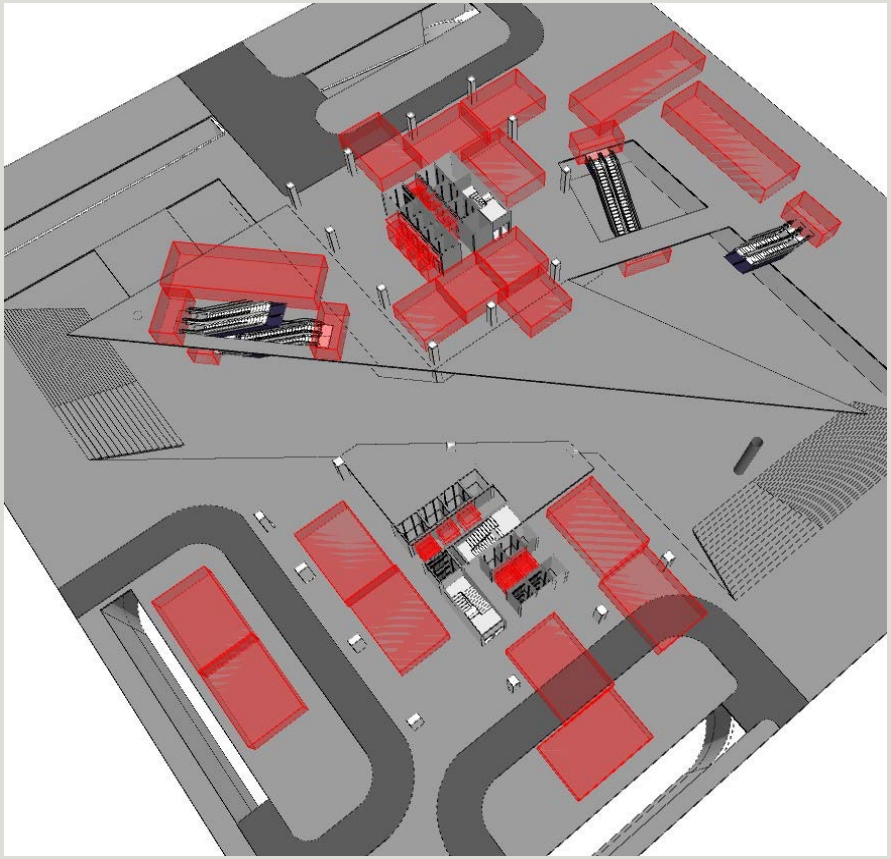


Navisworks – 4D Sequencing

Image Source: Autodesk University

Building Information Modeling

- **4D Simulation**
  - Help on-site management and safety management by enabling many project participants in the field to consistently understand the situation at the site.
  - The work space according to the construction sequence is checked in 3D, and information about the process by specialized company such as interior/exterior, equipment, etc. is reviewed with the person concerned to facilitate consultation.



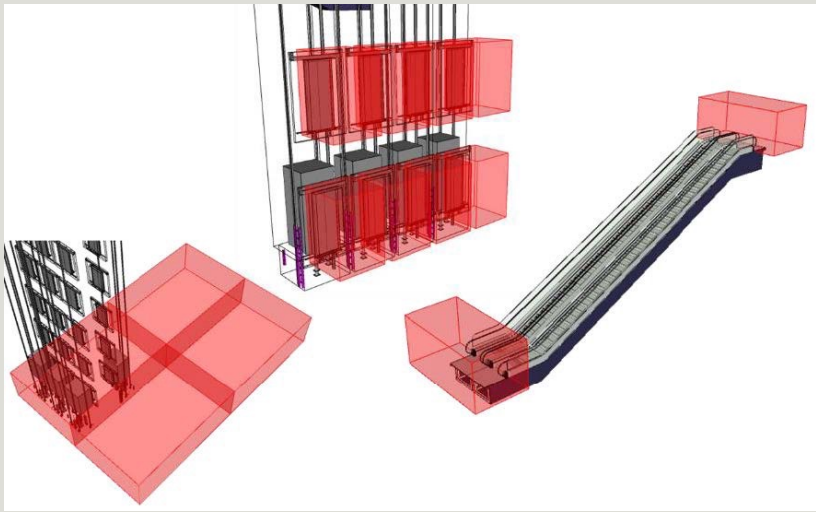
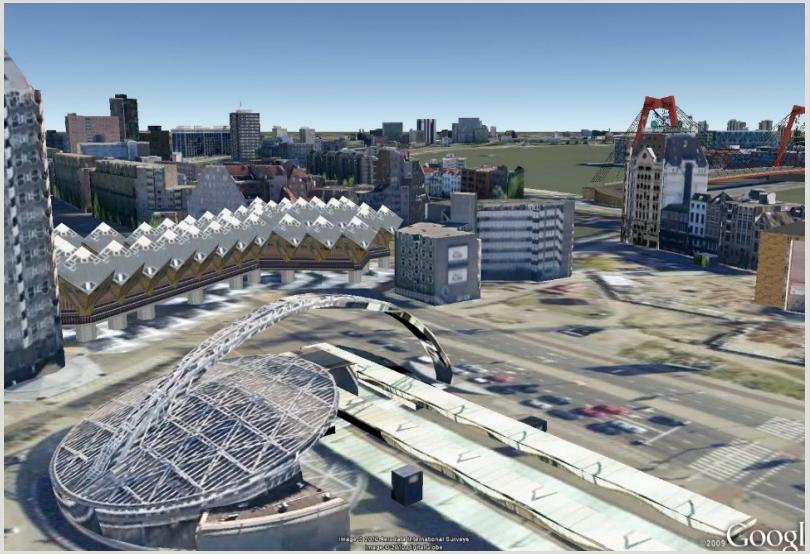


Image Source: Autodesk University

Building Information Modeling

- **4D Simulation**
  - Review whether it is possible to bring in or store heavy and long equipments or materials at the site.
  - Various factors can be taken into account, such as materials, equipment, and surrounding traffic conditions.

Revit Architecture/Sketchup/Google Earth – Site Coordination



Modeling the swing of a crane or the lifting of a steel frame, so that the flow of construction can be reviewed from various angles

Building Information Modeling

- **Pre-construction Meeting**

(1) Submit individual models of architecture, structure, machinery, equipment, etc.

- Individual companies are also required to have 3D BIM modeling skills to participate BIM project.

(2) Integral analysis of 3D models of individual specialist companies.

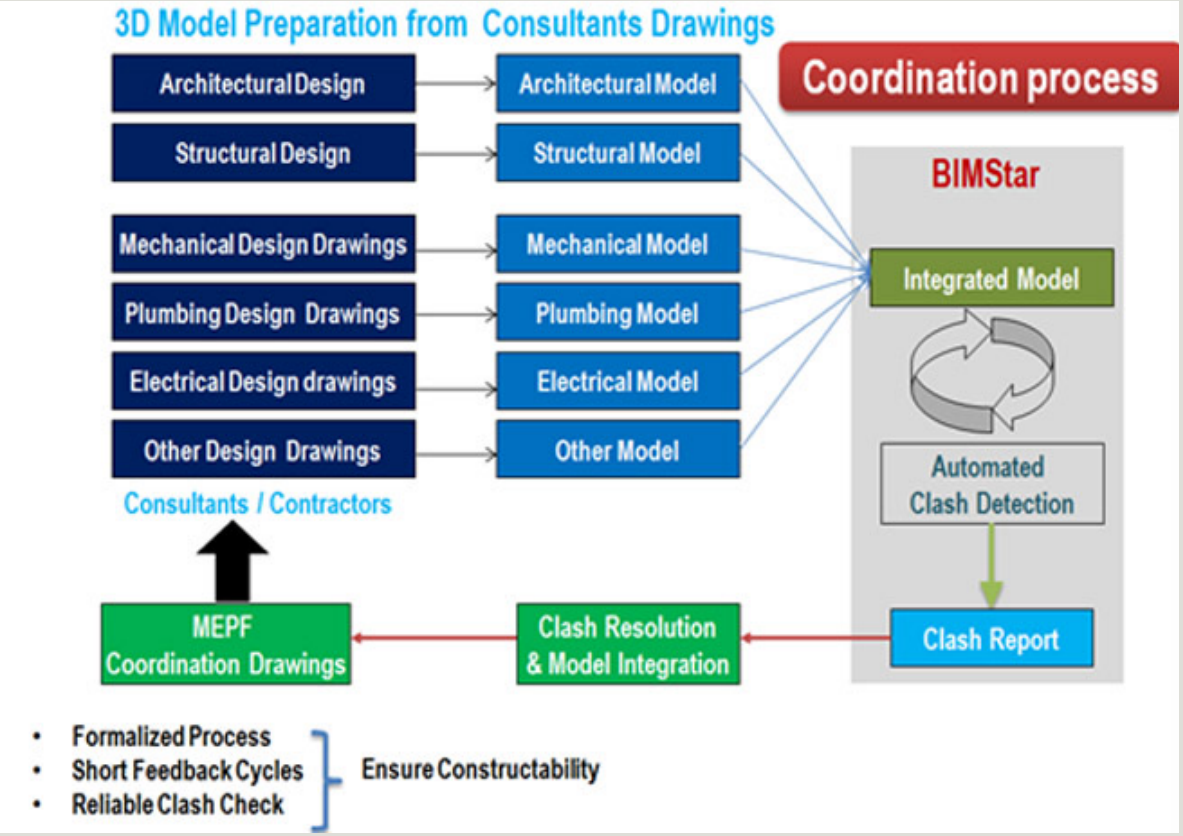
- Using software such as Navisworks.

(3) Communicate with the discovered issues and adjust the design (model).

- It is effectively used to find problems between members of different types of construction by specialized companies throughout the design stage, pre-construction stage, and construction stage.

Building Information Modeling

- **Pre-construction Meeting**
  - Iterative collaboration process



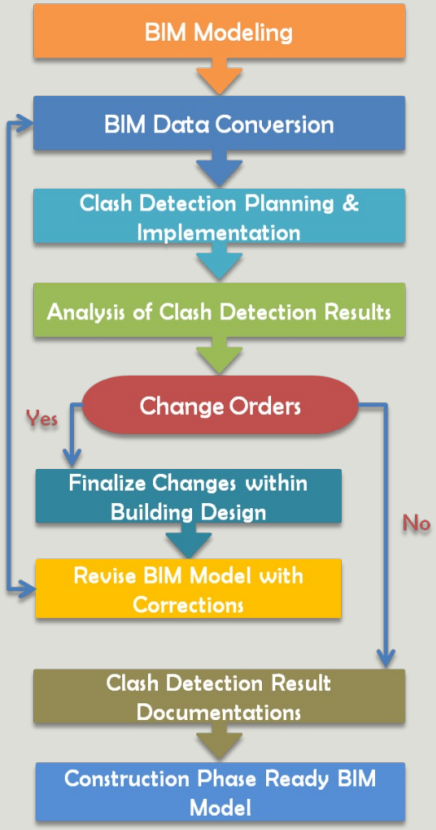


Image Source: (1) http://bimstar.co.in/clash-detection-clash-reports/
(2) http://www.revitmodelingindia.com/services/bim-clash-detection-services/

Building Information Modeling

- **Pre-construction Meeting**
  - Preliminary identification of on-site issues in the design stage and pre-construction stage
    → Reduction of rework
    → Shorten construction period, save construction cost

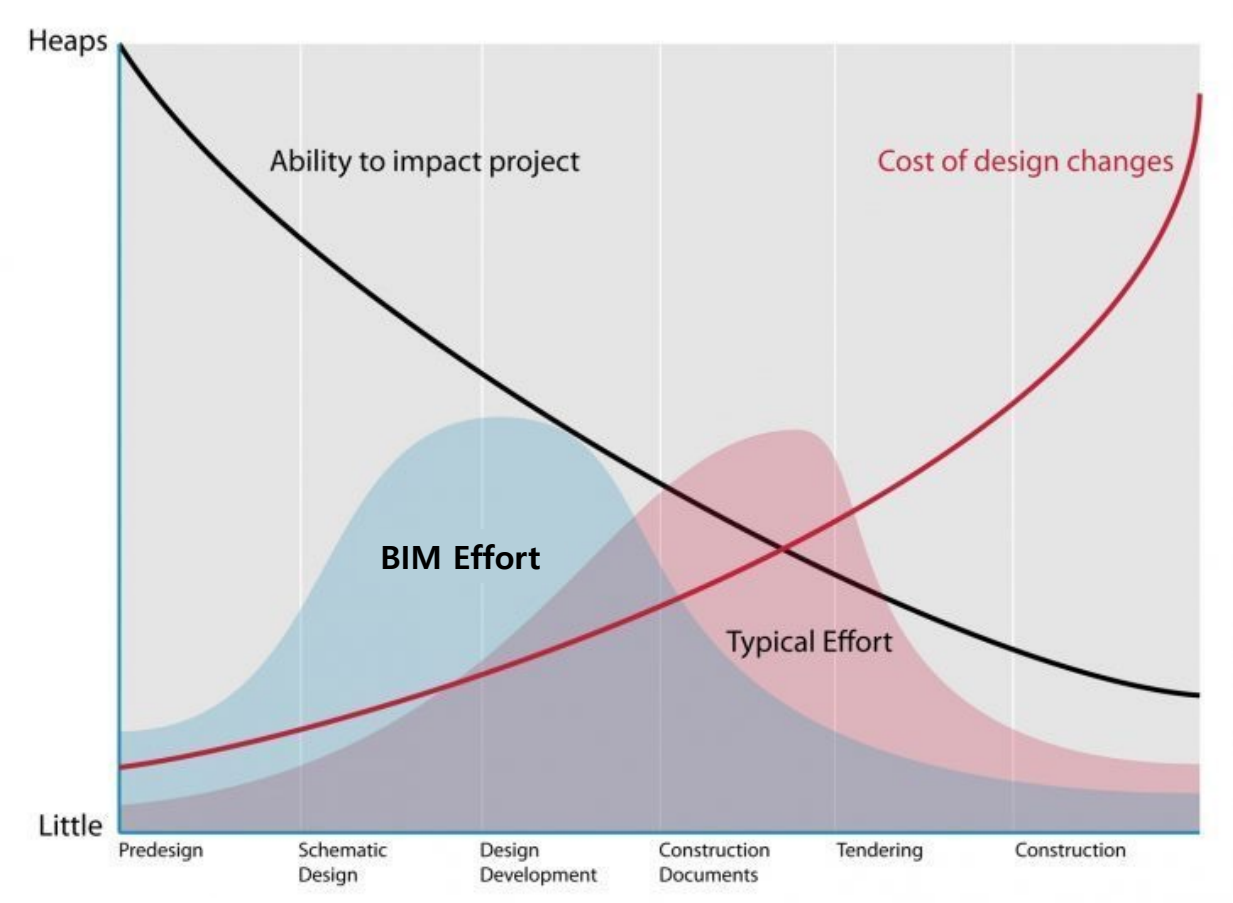


Image Source: MacLeamy curve (2004)

Building Information Modeling

- **BIM Applications**
  - One of the biggest benefits contractors can get from using BIM
  - Great improvement in resolving clash, understanding construction details, identifying drawing errors.

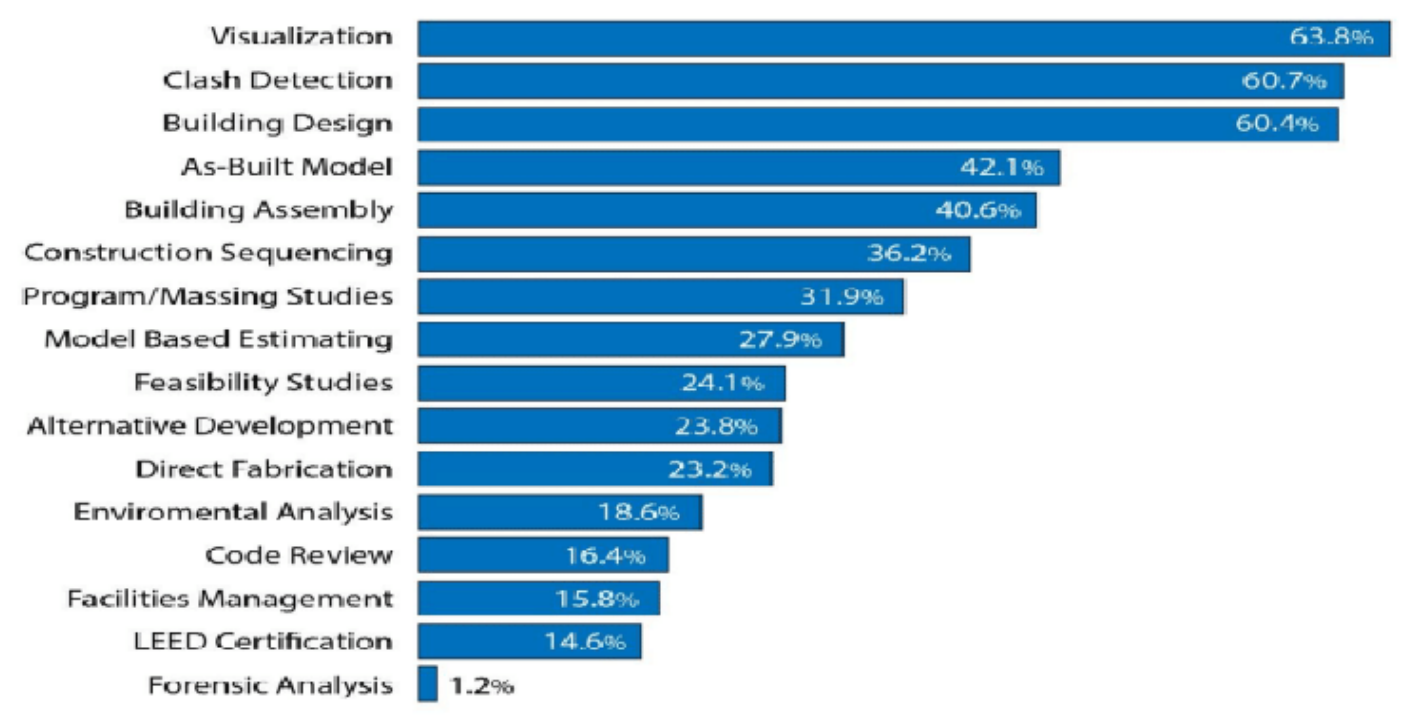


Image Source: B. Becerik-Gerber and S. Rice, The perceived value of building information modeling in the US building industry, J. of Information Technology in Construction, 15, 185-201, (2010)

Building Information Modeling

- **BIM Applications**
  - One hundred percent of MEP contractors and 90 percent of general contractors and structural engineers surveyed report participating in such integrated workflows — with tangible benefits to show for it.

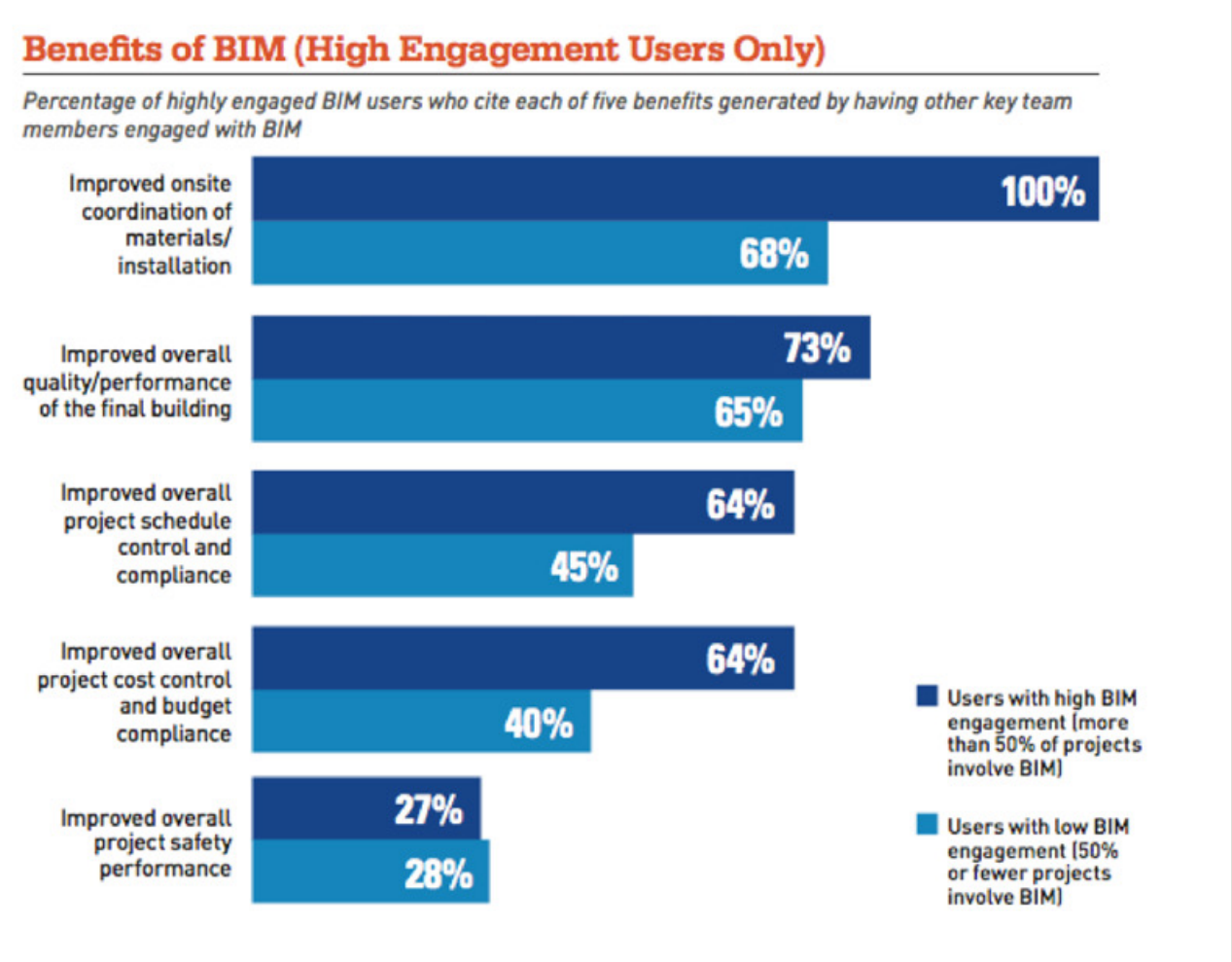


Image Source: https://projectdelivery.autodesk.com/blog/aec-industry-trends-bim-dodge-analytics/

Building Information Modeling

- **BIM Applications**
  - Starting with the US and Europe, national institutions and companies are actively promoting BIM introduction policies including guidelines and information standards.

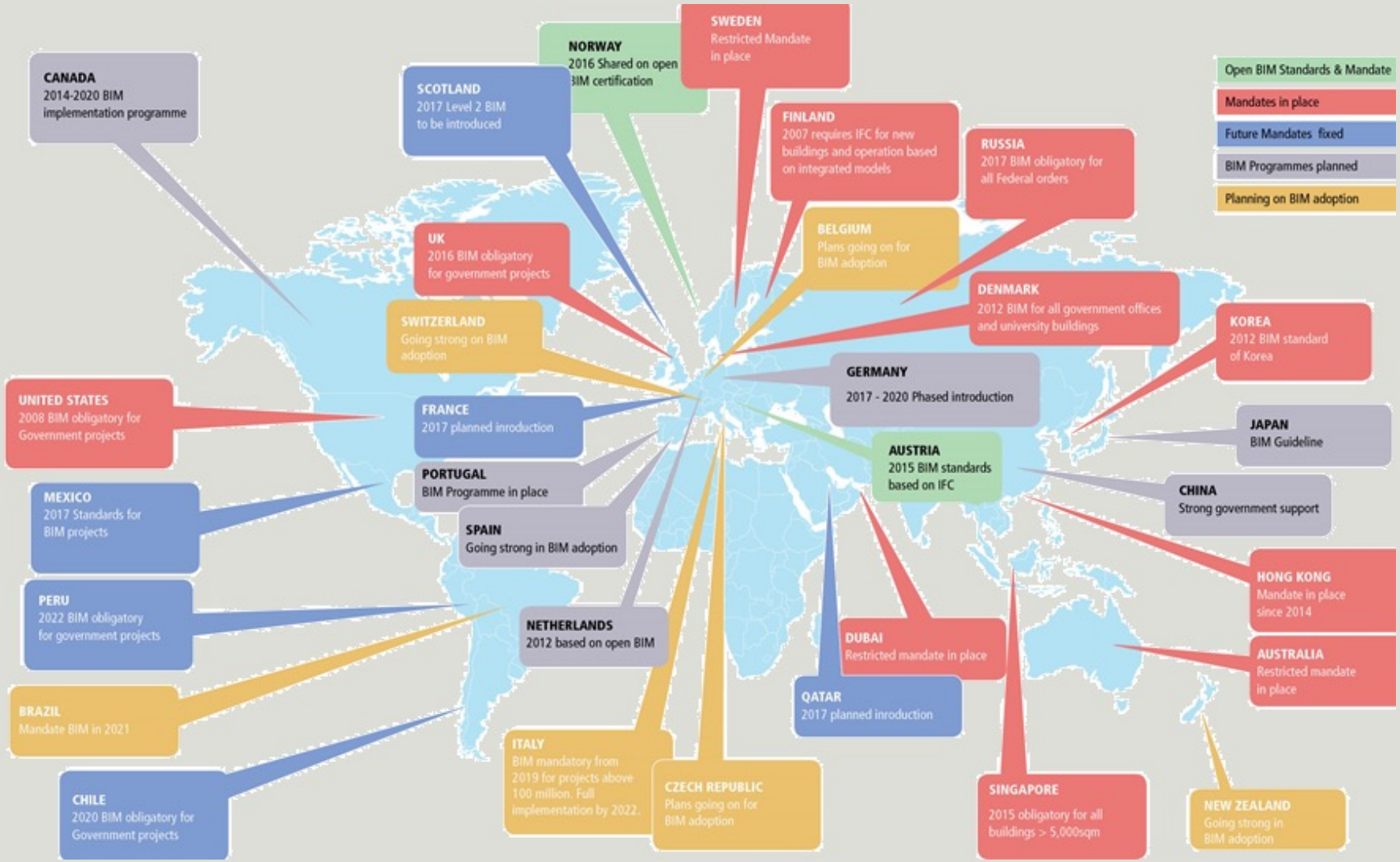


Image Source: https://www.geospatialworld.net/article/bim-adoption-around-the-world-how-good-are-we/

Building Information Modeling

▪ BIM Applications

- In South Korea, the Ministry of Land, Infrastructure and Transport continues to promote BIM activation policies in all fields of construction, civil engineering, and engineering and to prepare BIM mandatory plan and order for pilot project

BIM도입 활성화를 위한 국가정책 장단기 계획 (2009) : 10 년간 추진계획

세움터 고도화 기본계획 (2009) : 인허가 지능형 서비스에 BIM 도입

국토교통부

제 6 차 건설기술진흥기본계획 (2017) : 스마트 건설구현위한 BIM 핵심기술 적용

제 5 차 건설사업정보화진흥계획 (2017) : 인프라 BIM 활성화 및 플랫폼 개발

국토교통부 (2015) : 2020년까지 사회기반시설 (SOC) 공사 20% BIM 적용
국토교통부 (2017) : 2020년까지 500억 이상 공사 대상 BIM 발주 의무화

조달청

- 2016 년 : 시설사업 BIM 적용지침서 v 1.31 발표
- 2016 년부터 시설사업 전체 대상 BIM 발주 (50건, 2조 규모)
- 2017 년부터 입찰 시 BIM 도면 및 보고서 의무화

LH 한국토지주택공사

- 2011 년 : BIM 가이드라인 발표
- 2017 년 : Civil – BIM 도입 착수
- 2009 년 : 공동 주택 최초 BIM 현상 설계 도입
  - 양주 회천지구
  - 파주 운정지구

K water 한국수자원공사

- 2013 년 : BIM 마스터플랜 발표
- 2017 년부터 전사적 체계 구축
- 시범사업 수행
  - 낙동강 살리기 4개공구
  - 영주댐, 보현산댐
  - 대산임해산업지역 공업용수도

ex 한국도로공사

- 2014 년 : BIM 마스터플랜 발표
- 2015 년 : BIM 가이드라인 v 1.0
- 시범사업 수행
  - 부산외곽순환 고속도로
  - 대구순환 고속도로
  - 함양울산간 고속도로

Image Source: the Korea Institute of Civil Engineering and Building Technology

Building Information Modeling

- **BIM Applications**
  - 2010: 43% don't know BIM
  - 2020: 73% use BIM

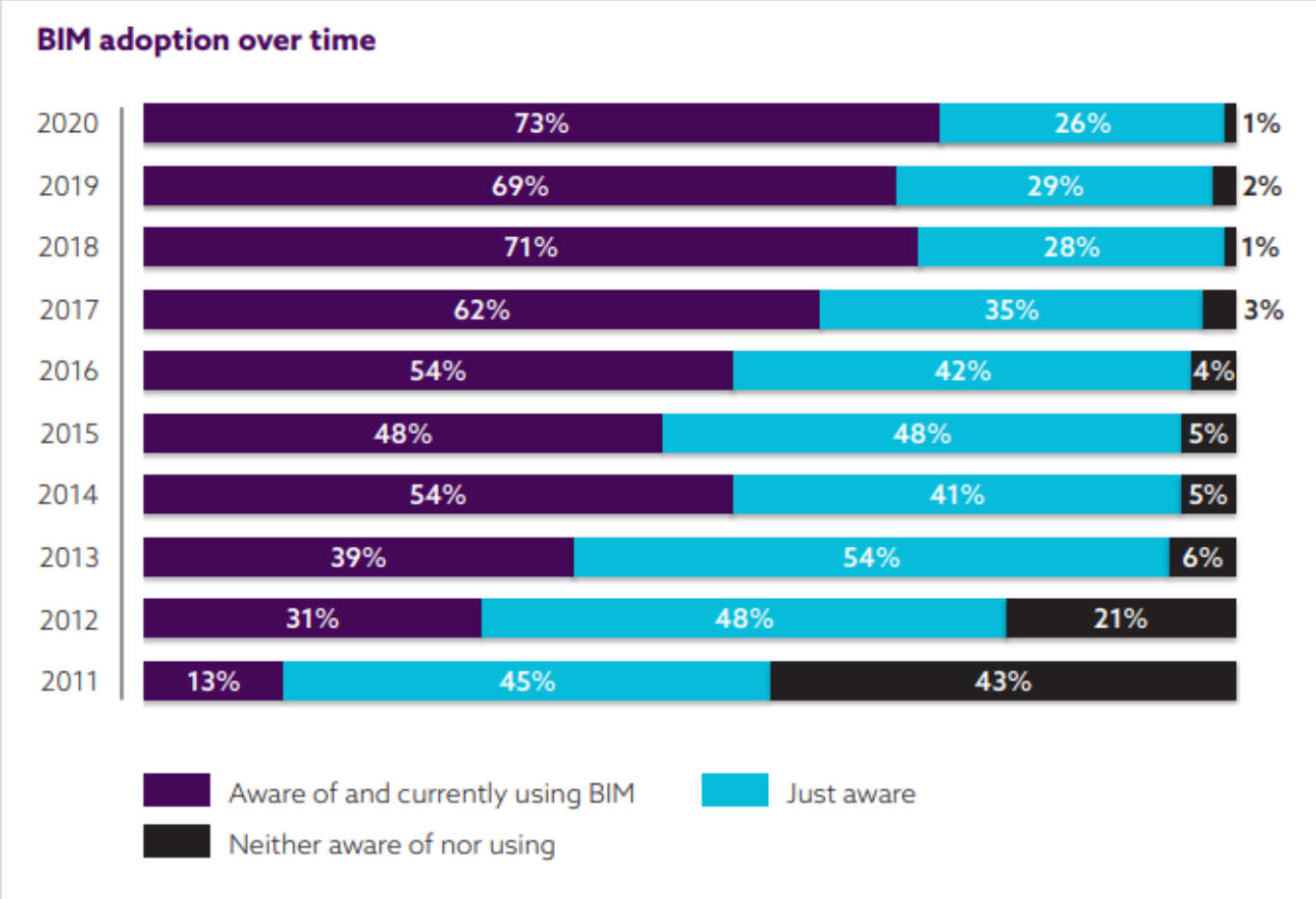


Image Source: https://www.thenbs.com/knowledge/national-bim-report-2020

Building Information Modeling

- **Future of BIM**
  - 4th Industrial Revolution

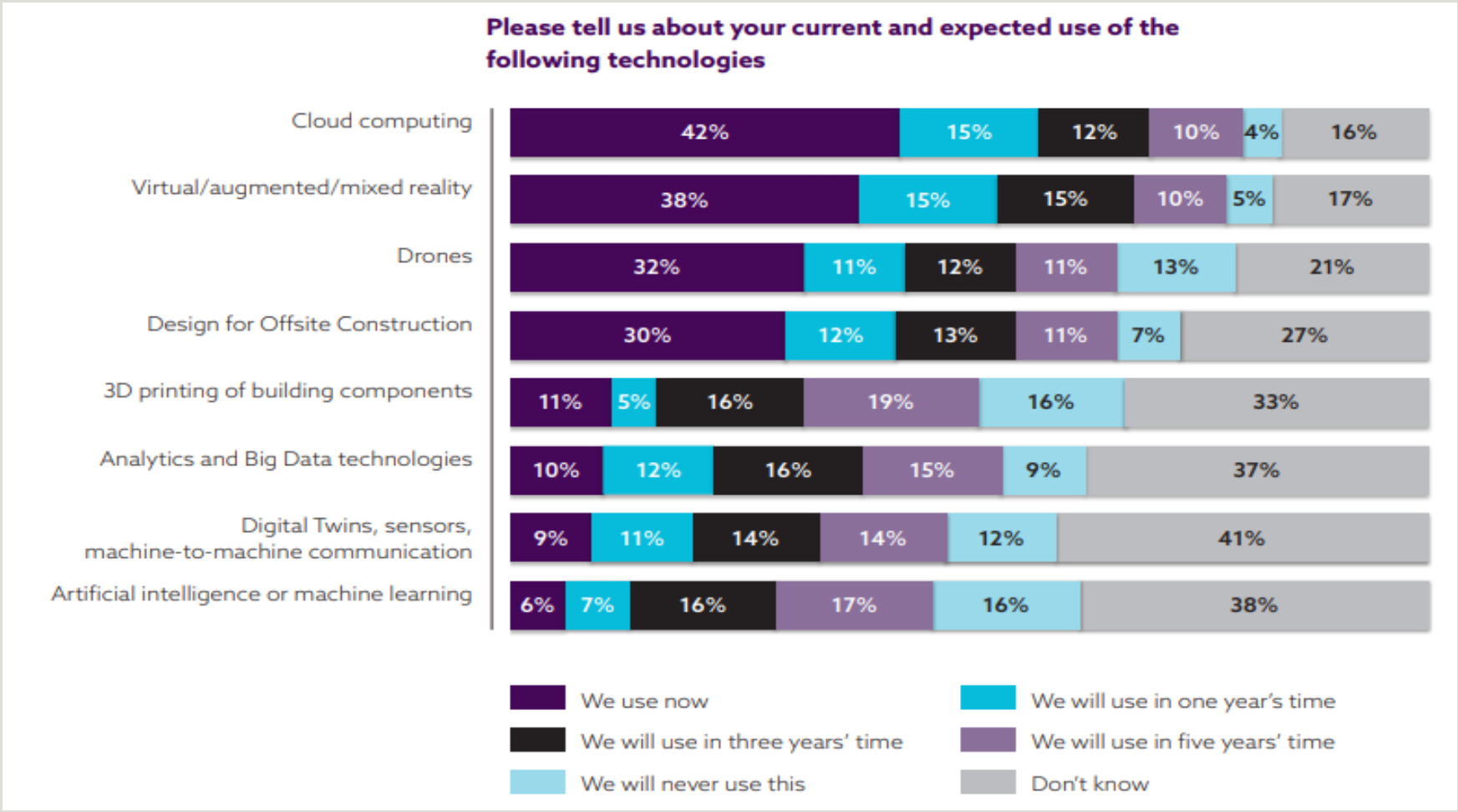


Image Source: https://www.thenbs.com/knowledge/national-bim-report-2020

Smart Construction

- **4th Industrial Revolution**
  - The next-generation industrial revolution brought about by the convergence of information and communication technology (ICT).
  - New technological innovations in areas such as big data analytics, artificial intelligence, robotics, Internet of Things, unmanned vehicles (drones, unmanned vehicles), 3D printing, and AR/VR technologies.

Image Source: http://news.unist.ac.kr/kor/column_202/

Smart Construction

▪ Smart Construction

- Various technologies to innovate productivity based on information sharing and connectivity of all participants in all stages of construction work, such as planning, design, construction, maintenance, and demolition, using the 4th industrial revolution element technology

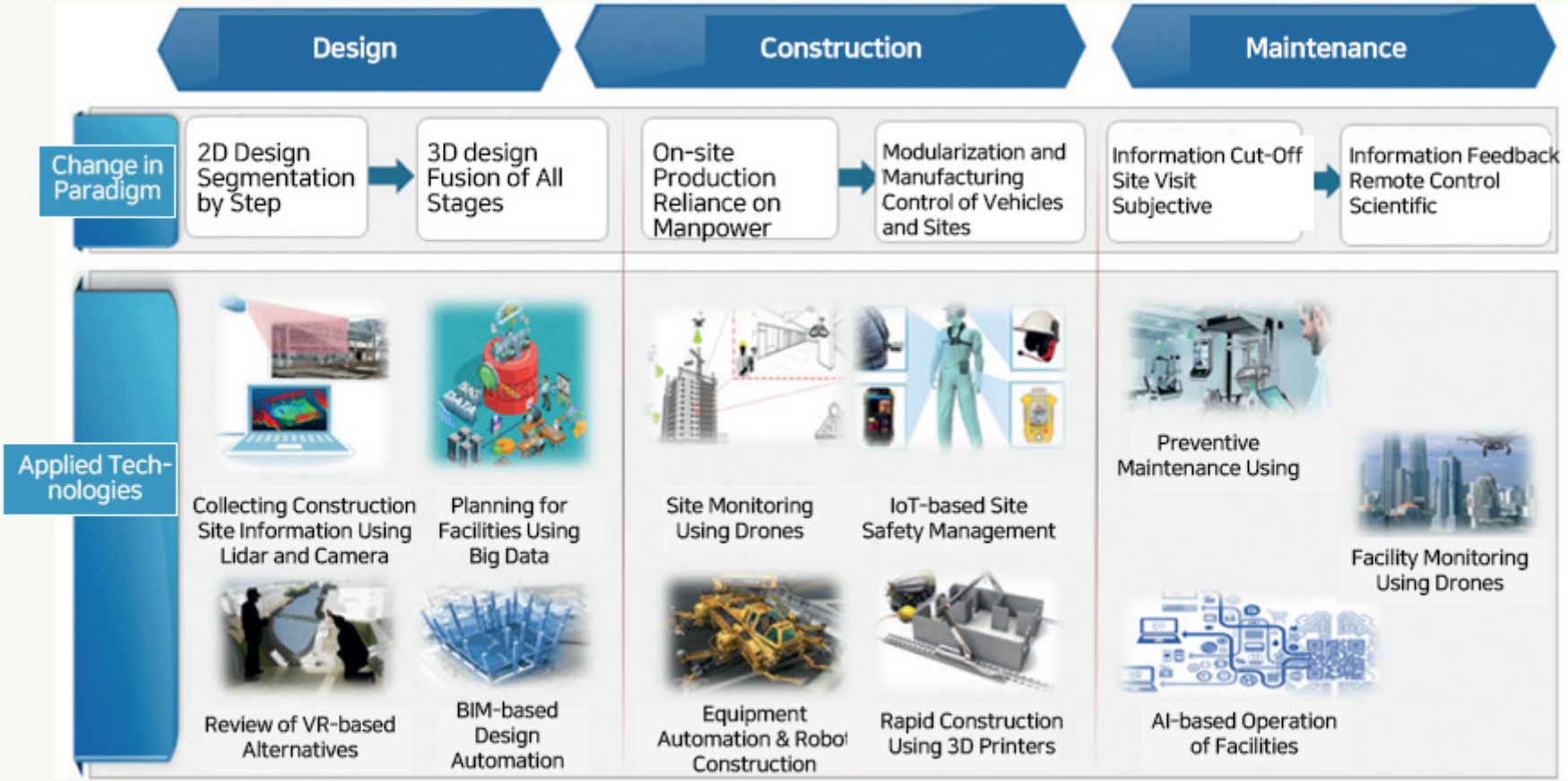


Figure 1 VR/AR Technologies in MOLIT's Smart Construction Technology Roadmap

Image Source: Ministry of Land, Infrastructure and Transport

Smart Construction

- **Smart Construction**
  - Experience-dependent industry → Paradigm shift to knowledge and high-tech industry
  - Overcoming the limitations of manpower → Improving productivity and safety

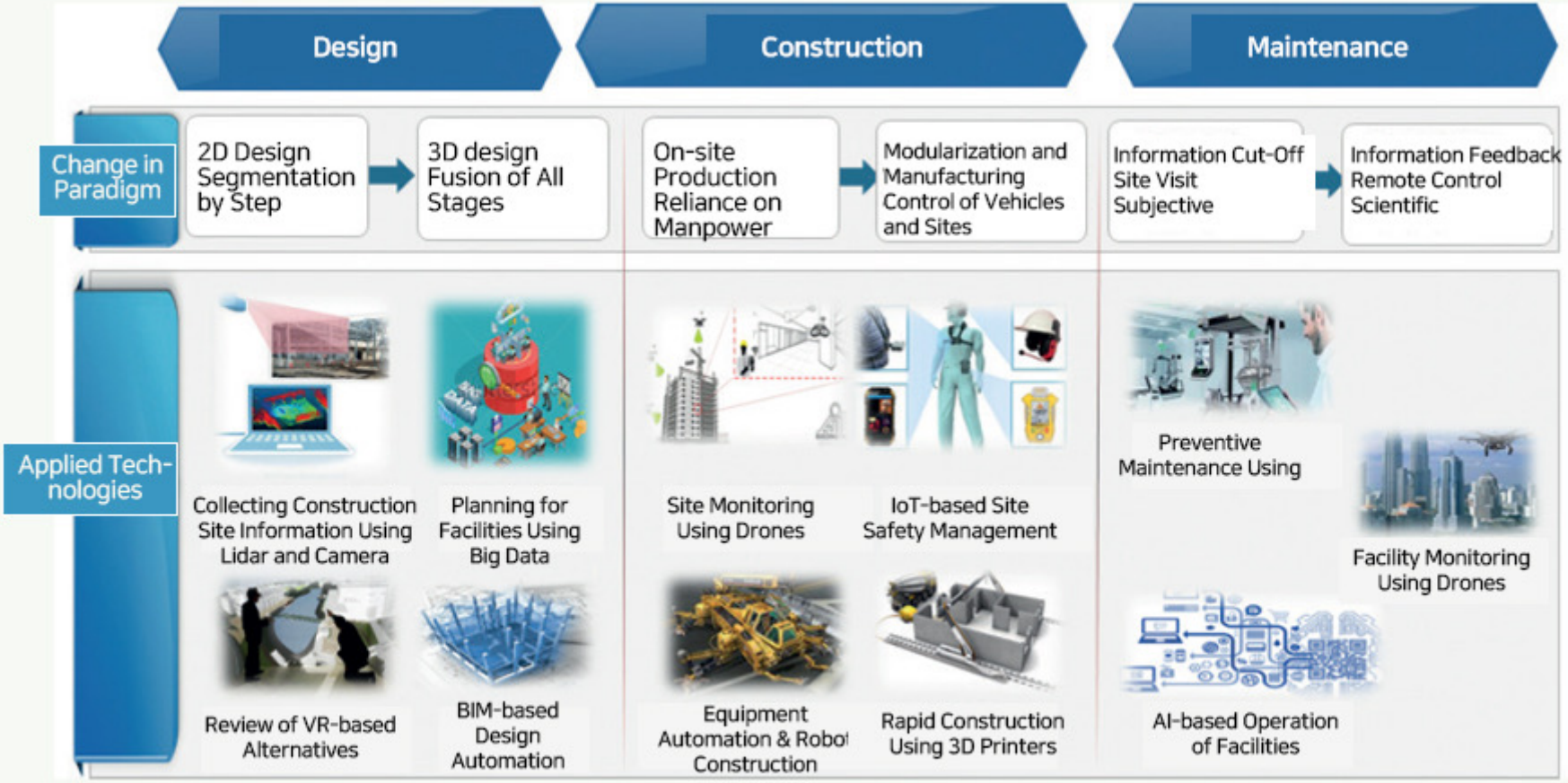


Figure 1 VR/AR Technologies in MOLIT's Smart Construction Technology Roadmap

Image Source: Ministry of Land, Infrastructure and Transport

Smart Construction

▪ Smart Construction

- Experience-dependent industry → Paradigm shift to knowledge and high-tech industry
- Overcoming the limitations of manpower → Improving productivity and safety

As-is	To-be
Data-oriented Decision Making	
Separated information	Information sharing and distribution
Experience-dependent	Optimization through data analysis
Repetition of trial and error	Prediction through simulation
Technology Convergence	
Separated individual	Activation of technology application
Segmentation by stages	Integration of all stages of construction
Manual and repetitive work	Communication and collaboration
Consumer-oriented technology	
Skilled labor	Automate workforce
2D	3D + α
Supplier-centric	Consumer participation

Source: Ministry of Land, Infrastructure and Transport

Smart Construction

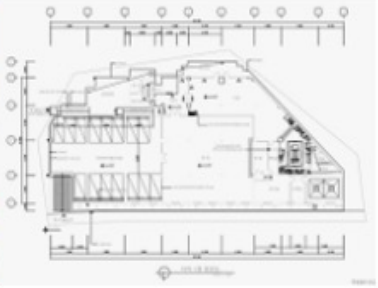
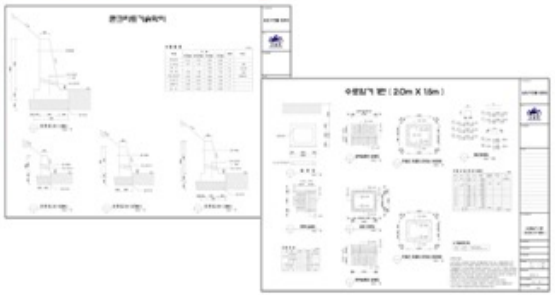
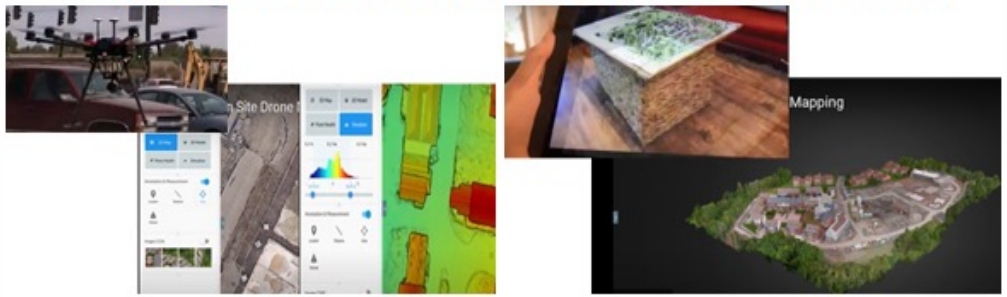
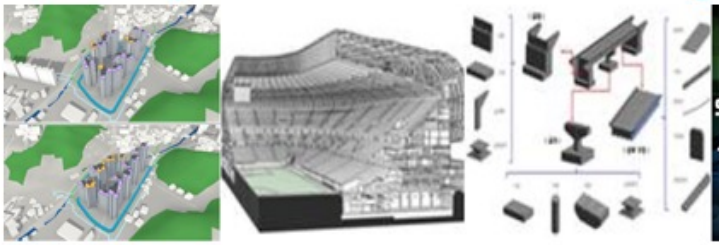
- **Smart Construction**
  - Application technologies: big data analytics, artificial intelligence, robotics, Internet of Things, unmanned vehicles (drones, unmanned vehicles), 3D printing, and AR/VR technologies.

Category	Technologies for Smart Construction
Platform	BIM, Cloud
Data collection	IoT, Sensor, Drone (UAV), Robotics
Data analysis	Big Data Analytics, Artificial Intelligence
Automatic Manufacture	Modular construction, 3D Printing
Applications	Virtual Reality, Augmented Reality

Smart Construction

▪ Smart Construction

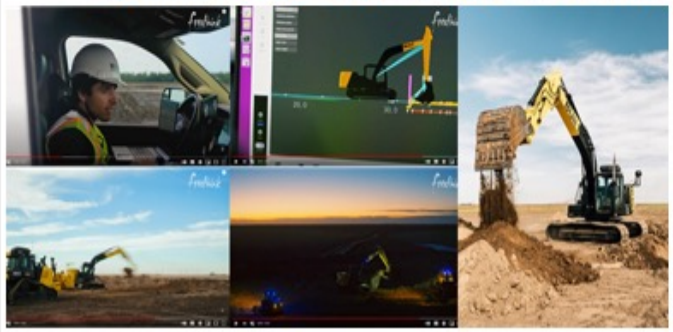
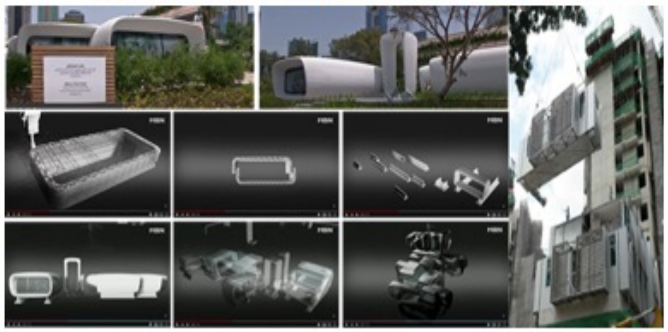
- Design stages

category	Data collection (measurement)	Design
As-is	✓ Labor-based → 2D data, time-consuming, limited area  Labor intensive  Manual drawing	✓ Manual drawing creation → error-prone, repetitive, time-consuming  Manual drawing  Standard drawing
To-be	✓ Drone + Camera → Rapid 3D model creation, no limitation in measuring  Reconstruction of 3D model using point cloud / images collected by drone	✓ BIM-based modeling, Automatic design using AI → Reducing error, Quality control, Cost Saving → Data platform for all construction stages  3D BIM  Automatic design using AI

Source: Ministry of Land, Infrastructure and Transport

Smart Construction

- **Smart Construction**
  - Construction stages

category	Civil works	Structural works	Finishing works
- As-is	✓ Manual operation → productivity and safety problem	✓ Labor intensive → productivity and safety problem	✓ Labor intensive → productivity and safety problem
			
	Manual driving of construction equipment	Dangerous site condition	Labor intensive works
+ To-be	✓ Automatic operation by AI → Optimization, Improve productivity	✓ Automatic Manufacture → Time/cost saving, Reduce accident	✓ Robotics application → Time/cost saving, Improve Quality
			
	Automatic operation, driving assistant by AI	3D Printing and Modular construction	Robotics applications in construction site

Source: Ministry of Land, Infrastructure and Transport

Smart Construction

▪ Smart Construction

- Operation and management stages

category	Construction Supervision	Operation and Management
As-is (-)	✓ Labor-oriented → error-prone by people, limited access, safety problem  Labor intensive works	✓ Labor-oriented → experience-based, quality control problem  Labor intensive works
To-be (+)	✓ Automatic data collection → Reduce workforce, Improve safety  Automatic data collection using robot, camera.	✓ Real-time information collection and management → data-based decision making > digital twin / smart-city  Real-time monitoring of construction site and buildings

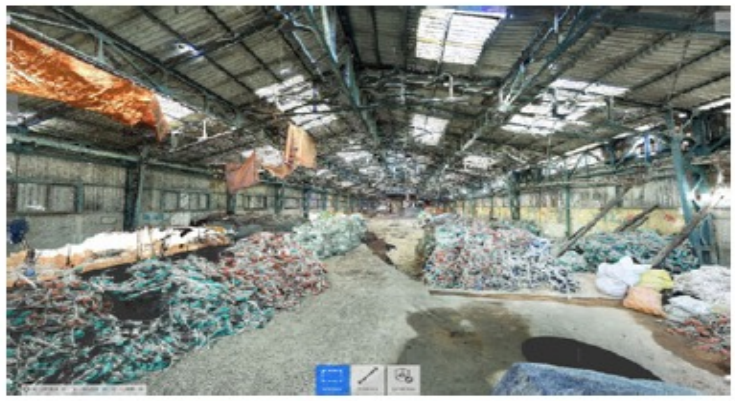
Source: Ministry of Land, Infrastructure and Transport

BIM & Smart Construction

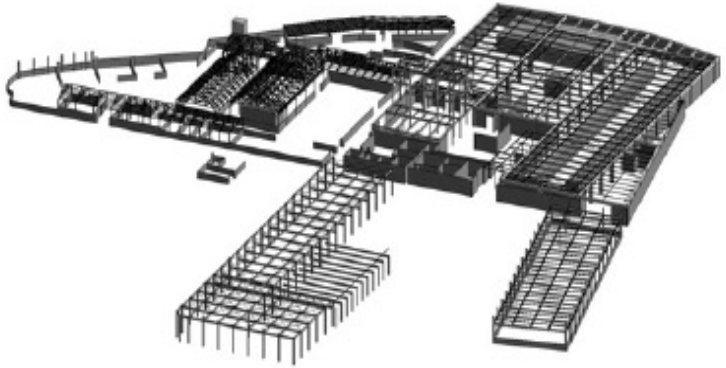
▪ BIM & Smart Construction

- Reverse engineering :
  Obtain design / engineering information of the building through 3D scanning or sensor and use it for project management (construction, maintenance).

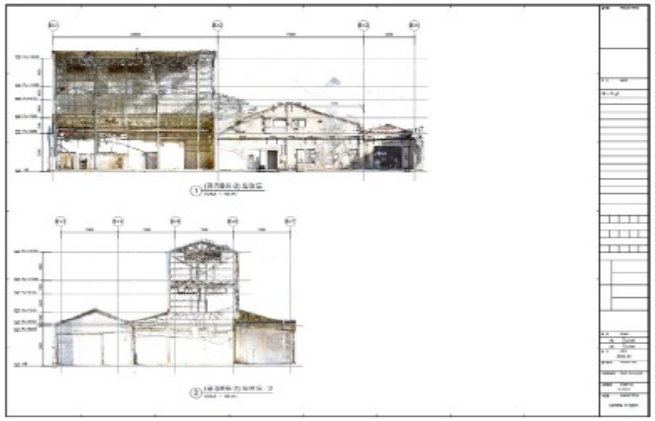
〈Fig. 8〉 On-site photo



〈Fig. 9〉 3D scanning data



〈Fig. 10〉 BIM model



〈Fig. 11〉 2D architectural drawing production

Source: Utilization of 3D scanner and BIM for uprising 4th industrial revolution

BIM & Smart Construction

▪ BIM & Smart Construction

- Virtual Reality / Augmented Reality:
  A number of studies have been conducted examining the utility of immersive VR/AR for promoting architectural design collaboration, project site management, worker safety education in a more immersive environment by implementing BIM project information in a virtual space.

Image Source: JBKnowledge (2015), BIManywhere (2015)

BIM & Smart Construction

▪ BIM & Smart Construction

- More than 20 years have passed since BIM was applied in the construction field.
- As successful cases of BIM project are shared, the need to apply BIM and the will to adopt it arises.
- At the same time, skepticism about BIM arose as several failure cases were accumulated.
- It is judged to be a stage of re-lighting in Gartner's Hype-cycle.

BIM do all

- **Integrated project management**
- **Productivity improvement**
- **Project success**

BIM skepticism

- **Initial investment**
- **Added work process**
- **Apply BIM for showing**

BIM again ?

- **Digital project management**
- **Industry competitiveness**
- **Platform for smart construction**

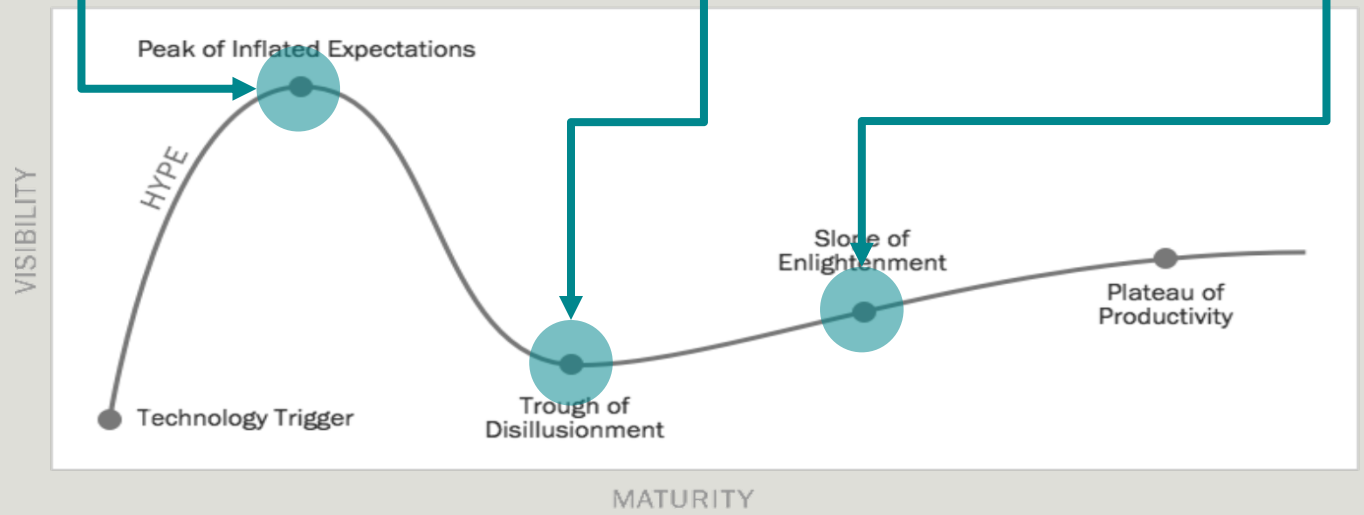
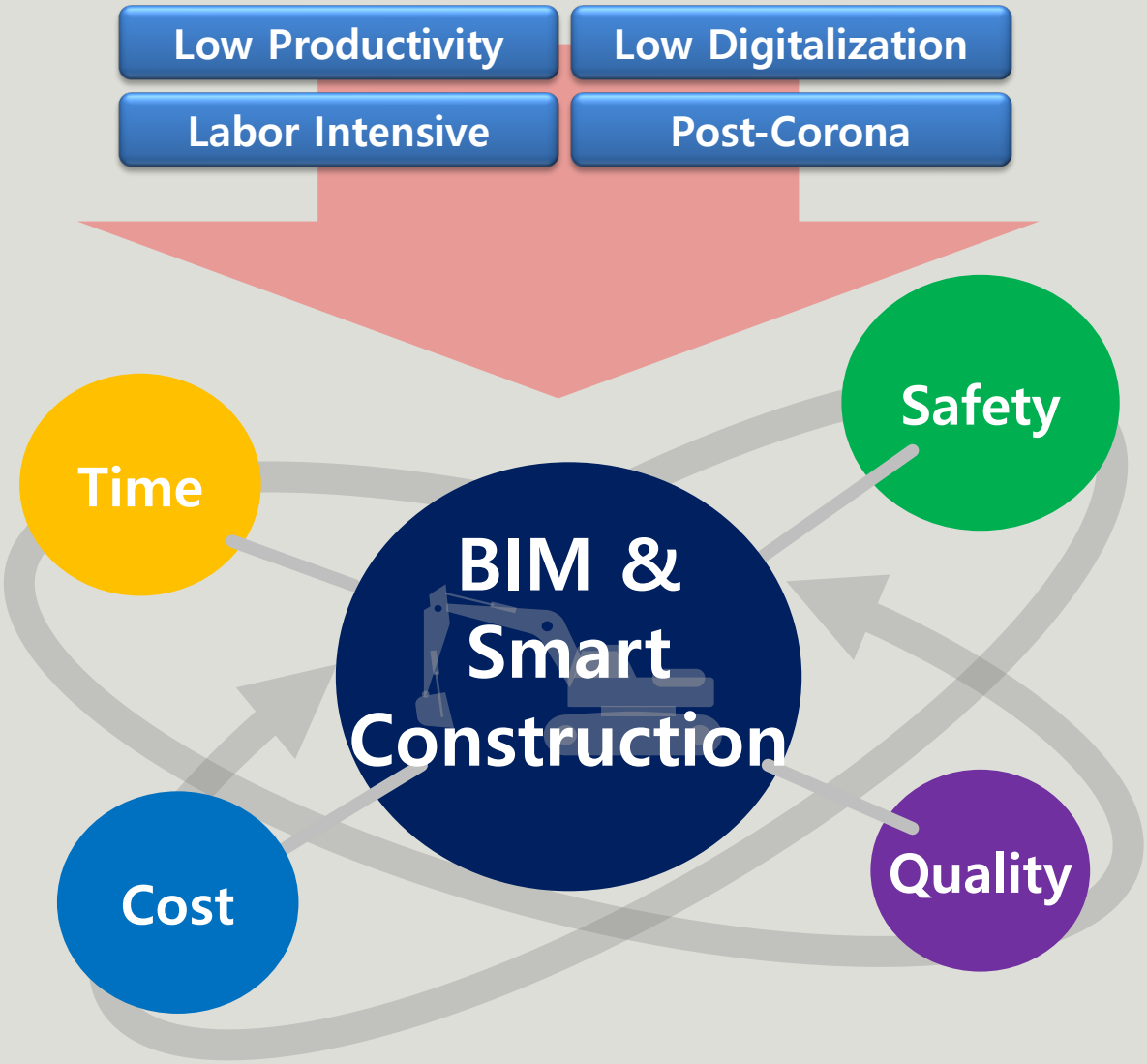


Image Source: Hype-cycle (Gartner)

BIM & Smart Construction

- **Summary**
  - Problem Identification at the Early Stages of Construction
  - Technologies for Tracking the Construction Process



Modernization of Uzbekistan Building Code (UBC) System

Thank you

국토교통부
Ministry of Land, Infrastructure and Transport

해외건설협회
International Contractors Association of Korea

KICT
한국건설기술연구원

서울시립대학교
UNIVERSITY OF SEOUL

RICON
KOREA RESEARCH INSTITUTE FOR CONSTRUCTION POLICY