



BIM Developments in Singapore

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Outline

- Introduction
- Background of BIM developments
 - Including national strategic goals & past initiatives
- New initiatives
 - Including CITM, IDD, DfMA, VDC/ Computational BIM, BETA
- Recent Technological Trends
- Discussion
- Conclusion



INTRODUCTION

- Building Information Modelling
 - A process involving the generation and management of digital models (representations of physical and functional characteristics of places)
 - Building information models can be exchanged and networked to support the exchange of information for decision making
- Widely adopted in the building and construction industries of many countries
 - Singapore too recognizes the importance of BIM in its plans to modernize the construction industry and improve construction productivity.



Purpose

- Provide an overview of the context and key developments which will
 - drive the future adoption of BIM in Singapore, and
 - help Singapore realize its ambition to transform the industry from one that is
 - fragmented, and
 - struggling to achieve its productivity goals
 - into one that is
 - digitally integrated, and reaping the benefits of
 - technology automation through digitalization
- Initiate discussion & exchange of ideas.

Background of BIM developments

Construction productivity

- Singapore is heavily reliant on foreign construction workers, tradesmen and technicians
- Sources
 - General construction workers
 - Traditional: India, Bangladesh
 - Tradesman/ technicians
 - Traditionally from Malaysia; now also from China, Philippines, Myanmar
- Construction site-work is seen as dangerous, dirty and not rewarding by locals.

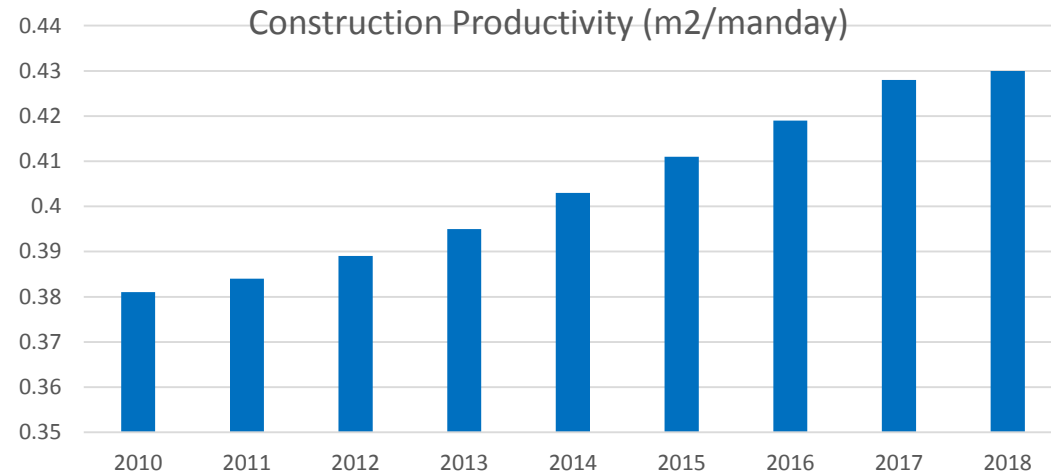




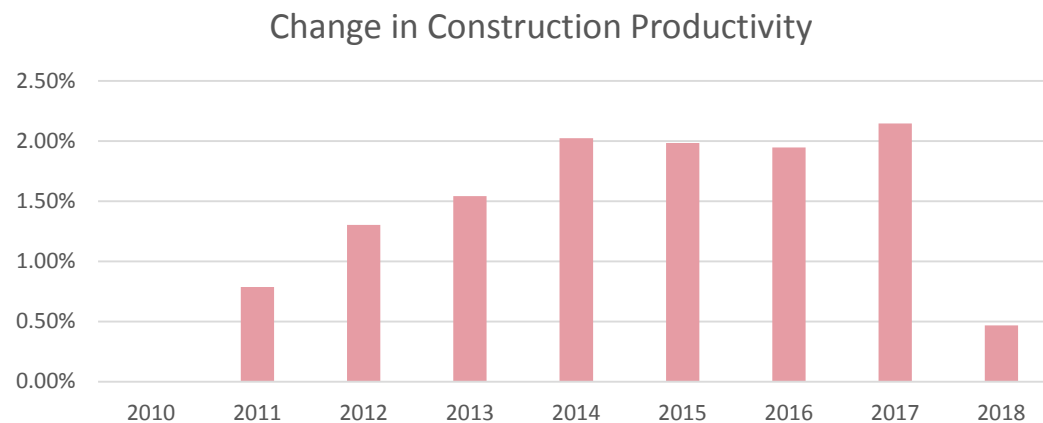
Construction productivity

- Foreign workers are only allowed to stay for 3-5 years on a work permit system
- Employers are subject to FW quotas, and dependency ratios
- Constant turnover of workers
 - Recurring costs in worker training and familiarization
 - skill/ knowledge retention problematic
 - Low rate of construction productivity gain
- Government encouragement to substitute capital factor for low-skilled labor for productivity improvement.

Construction productivity



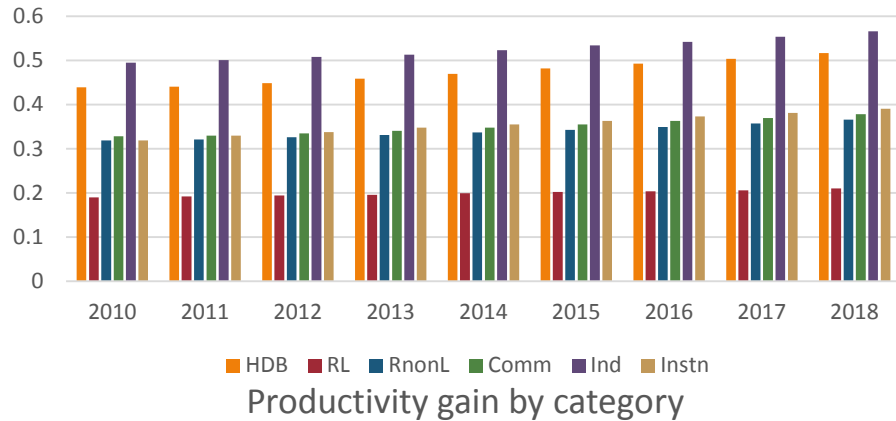
- Overall productivity at the industry level has been on the increase
- However, it is a struggle to maintain productivity gain on a yearly basis.



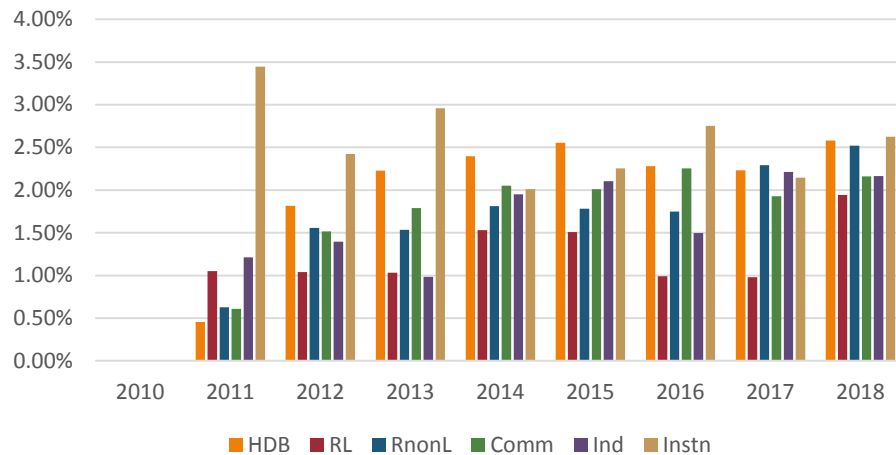
Source: BCA - Site productivity statistics

Construction productivity by category

Productivity by category (m2/manday)



Productivity gain by category



- Public housing (HDB) and Industrial buildings show the highest productivity
- Industrial buildings maintain a high level of annual productivity gain
- Public housing has shown a dramatic rise in productivity gain.

Source: BCA - Site productivity statistics



Strategic goals

1. Improve construction productivity
2. Improve health and safety
3. Lessen dependence on foreign construction workers
4. Improve quality of built product
5. Increase value, reduce waste
6. Enable innovation both in product and delivery process.

Role(s) of Building Construction Authority (BCA)

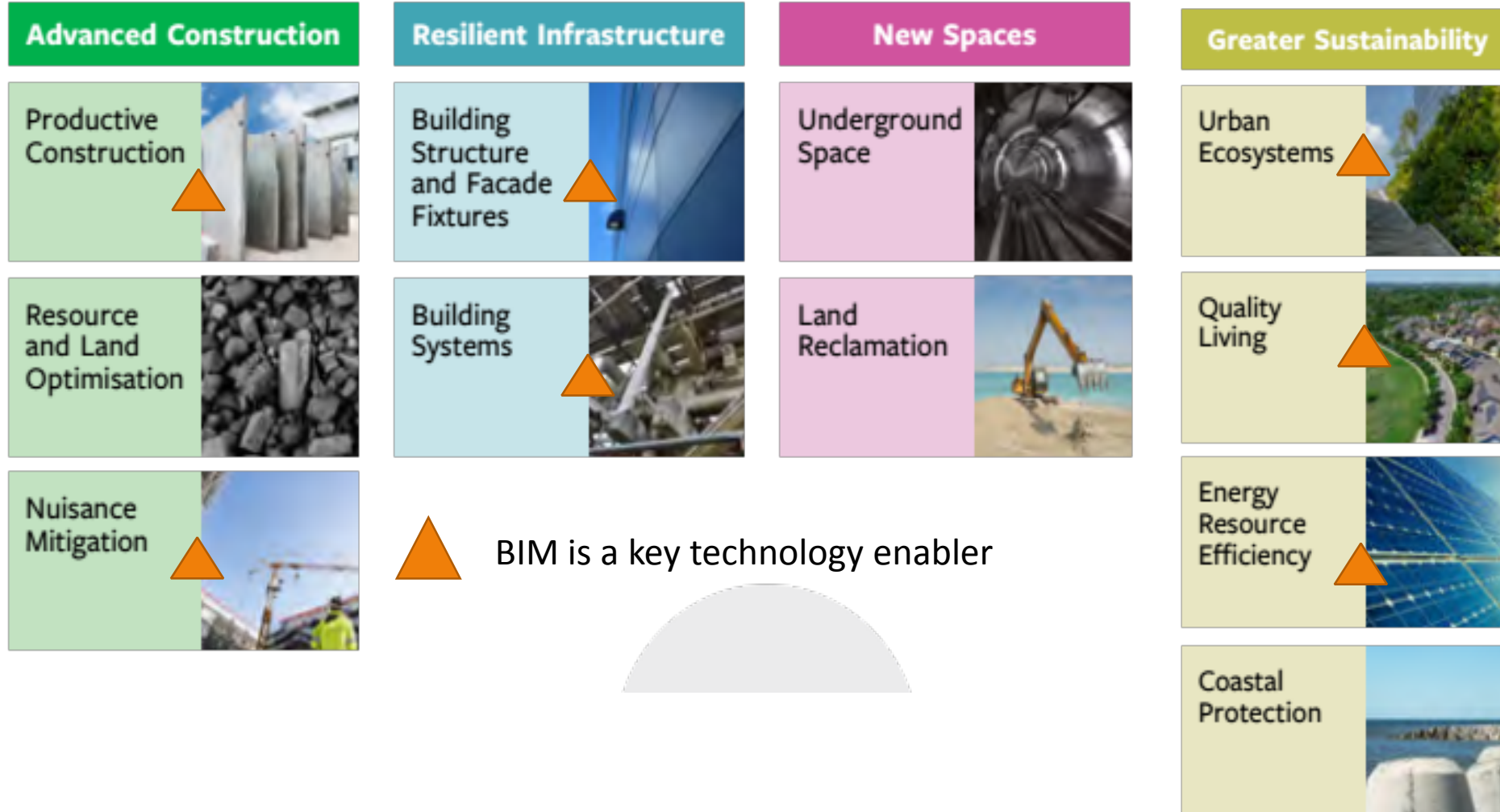
- Regulator
 - Building approvals, foreign worker quotas
- Change agent & coordinator, overseer of industry transformation
- Administrator of funds for government programs and initiatives
- Driver of industry standards and process standardization
- Provider of skills training and construction education
 - BCA Academy; Center for Lean & Virtual Construction



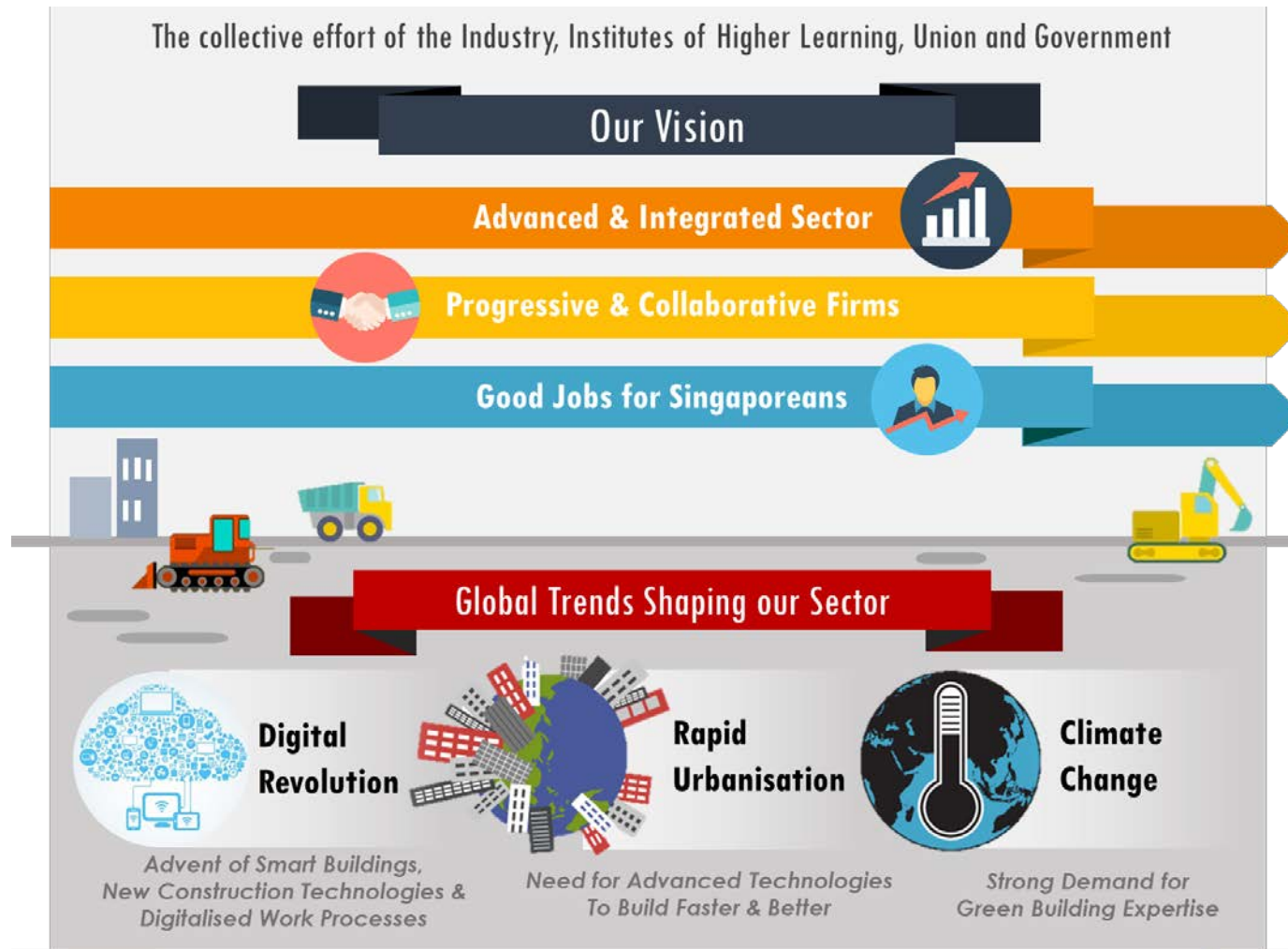
BCA/CLVC

NEW INITIATIVES

Cities of Tomorrow (CoT) Program Research Verticals



Construction Industry Transformation Map (CITM) 2019



Key constraints

1. Limited land
2. Heavily dependent on imports of energy and goods
3. Aging population
4. Economy shifting to services especially knowledge intensive services

3 Key Areas to Transform the Sector

Design for Manufacturing & Assembly (DfMA)



Design upfront for ease of manufacturing and assembly



Highly automated offsite production facilities



Efficient and clean on-site installation process

Green Buildings



Design for Green Buildings



Sustainable practices in operations and maintenance

Integrated Digital Delivery (IDD)



Enabled by Building Information Modelling (BIM), IDD fully integrates processes and stakeholders along the value chain through advanced info-communications technology (ICT) and smart technologies.

DfMA

- Concept originated in the manufacturing sector
- In construction, DfMA will enable
 - ease of off-site manufacturing (precast, prefabrication) and
 - efficiency of on-site assembly
 - Creating factory-like conditions for the fabrication, construction and assembly of units to be constructed
- DfMA elements
 - Precast structural and architectural elements
 - Cross Laminate Timber (CLT)
 - Prefabricated Bathroom Units (PBU)
 - Prefabricated Kitchen Units (PKU)
 - Integrated Prefabricated M&E Units
 - Prefabricated Pre-finished Volumetric Construction (PPVC).

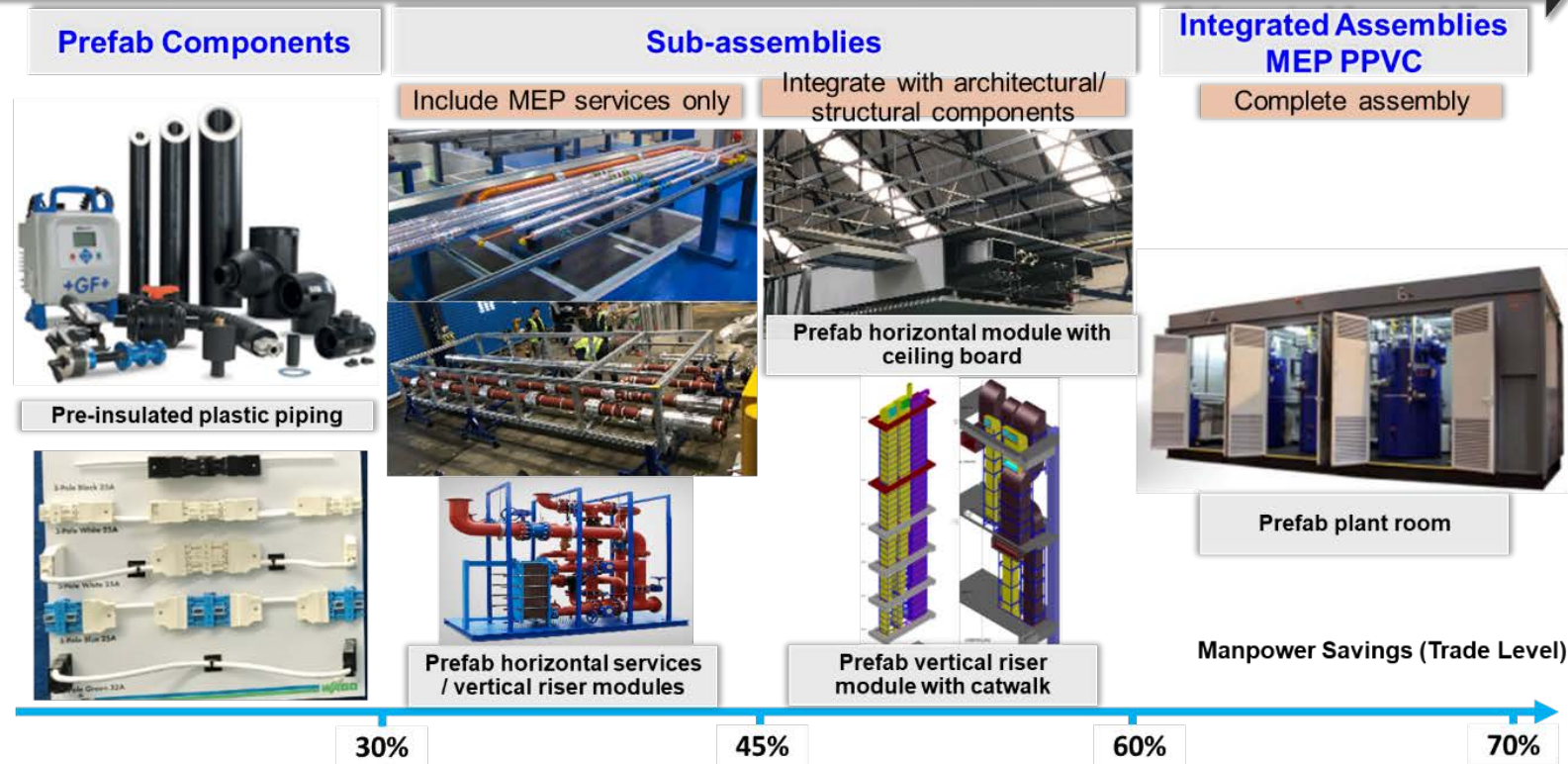


Zaobao

Prefabricated MEP

Components:
Incremental Improvement...

...Integrated Assemblies:
Game-Changing Improvement



- Significant benefits in project delivery
 - less manpower needed on-site
 - reduced downtime
 - improved quality of MEP works
 - safer and more conducive environment for MEP trade workers.

PPVC

- Free-standing 3-dimensional modules are completed with internal finishes, fixtures and fittings in an off-site fabrication facility before it is delivered and installed on site
- Key considerations
 - Modularization of built-up space
 - Coordination of building services
 - Water tightness between modules
 - Structural robustness
 - Fire safety
 - Just-in-time delivery & assembly
 - Bulky transport to site
 - Heavy lift & assembly



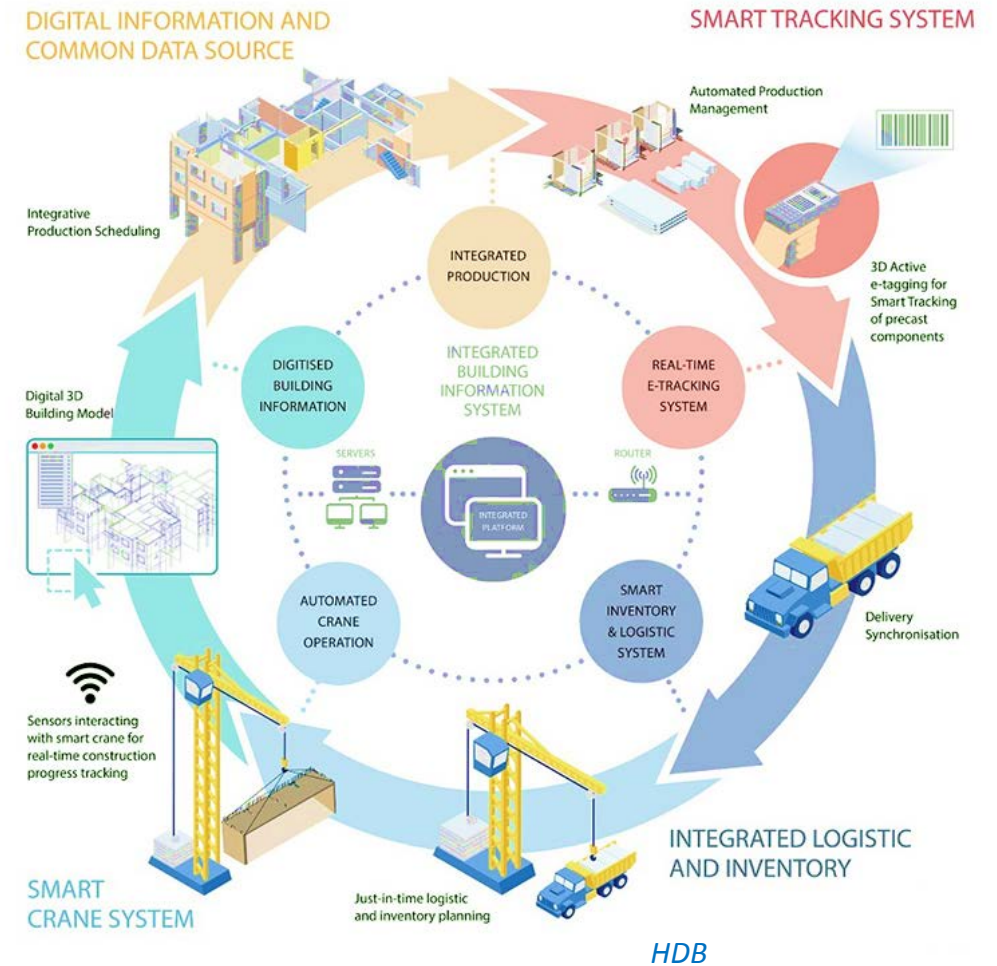
Virtual Design & Construction

- Use of Computational BIM to perform building analysis
 - Cooling, ventilation and building comfort
 - Energy efficiency
 - Structural analysis
 - Fire safety
 - Movement and transport of goods & people within building
 - Vehicle traffic studies
- Work collaboratively on a common design goal
- Improve site coordination among sub-contractors
- Uncover mistakes, correct wrong assumptions, resolve problems before actual construction
- Use of Virtual Reality (VR) and Mixed Reality to visualize results
- *Build twice, first virtual then real*

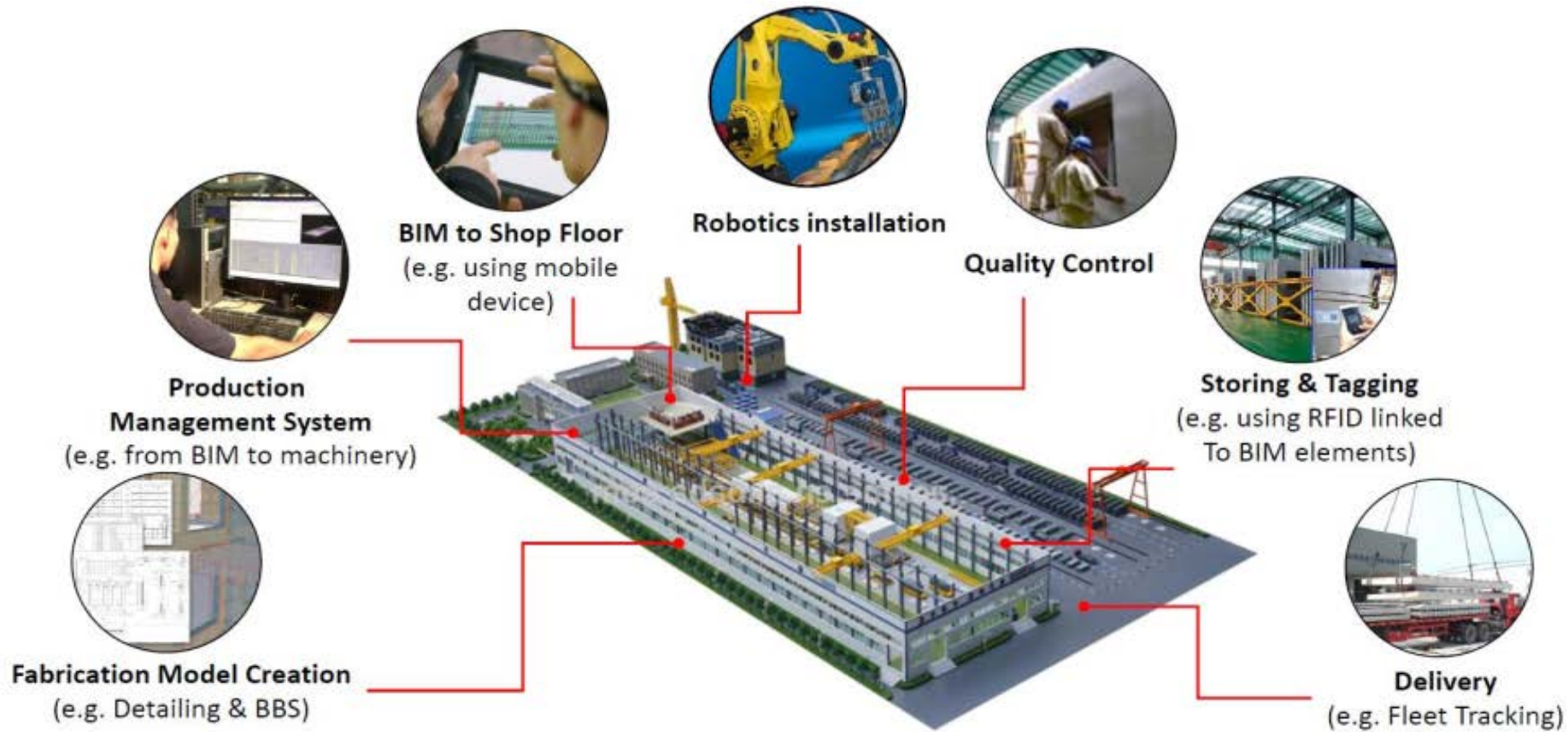



Integrated Digital Delivery

- Use of a shared digital model, collaborative digital workflows and ICT for
 - Feasibility and concept study
 - Architectural Design & Engineering
 - Plan submission and regulatory approval
 - Procurement
 - Manufacturing & Fabrication
 - Construction Planning, Progress Monitoring and Management
 - Construction automation/ Crane Automation/Materials tracking
 - Payments and quantity surveying
 - Quality and defects management
 - Asset delivery and handover.



Manufacturing and fabrication





BETA (2019)

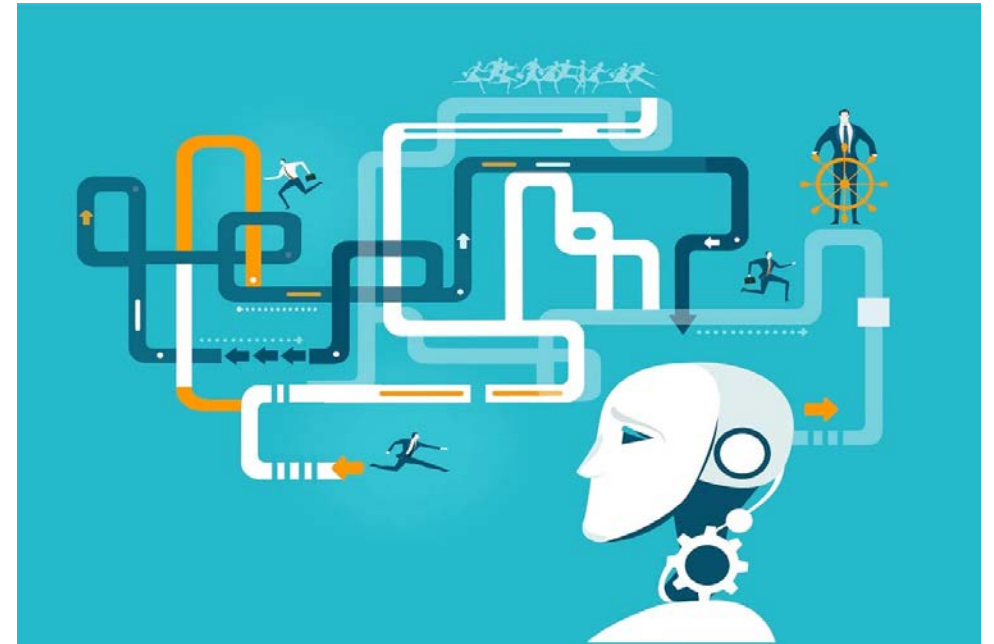
- Built Environment Technology Alliance
- First step in building a sustainable ecosystem around the use of BIM in the construction industry
- Driven by the public sector (housing, public and industrial infrastructure)
 - but the private sector will not be left behind
- Catalyse research and innovation (R&I)
 - Share specialized equipment & facilities related to address national issues
 - Access to testbeds with the required scale for proving and validation
 - Anchor-points for national programs to develop key capabilities
 - Provide flexibility of assembling consortiums of firms, experts for key projects in the national program
 - Developing a persistent and sharable knowledge-base of lessons learned, experience
 - Provide a 'sandbox' to validate innovations at scale and address regulatory concerns.
- Currently, an Inventory of key resources, specialized facilities, capabilities and expertise relevant to IDD, construction automation, DfMA and BIM in IHLs, public research agencies and private firms is underway.

Recent Technological Trends



The New Normal

- Increased capability to model larger projects in a multi-disciplinary way
- Moving to `cloud` data storage and analytical functionality
- Emphasis on green technology & greater sustainability
- Emphasis on Smart Buildings and cybersecurity.





Integration with other technologies

- 3D printing
- Digitalization via laser scanning
- Aerial drones
- Visualization - AR/VR/MR
- Robotics & construction automation
- IoT sensors
- Robotic Process Automation/ RPA

Hybrid models involving Artificial Intelligence

BIM capability
Element description
Geometric description
Spatial positioning
Functional constraints
Data Storage & Retrieval
<i>Type hierarchy</i>
<i>Part structure hierarchy</i>
<i>Topological relations</i>
<i>Information traceability</i>

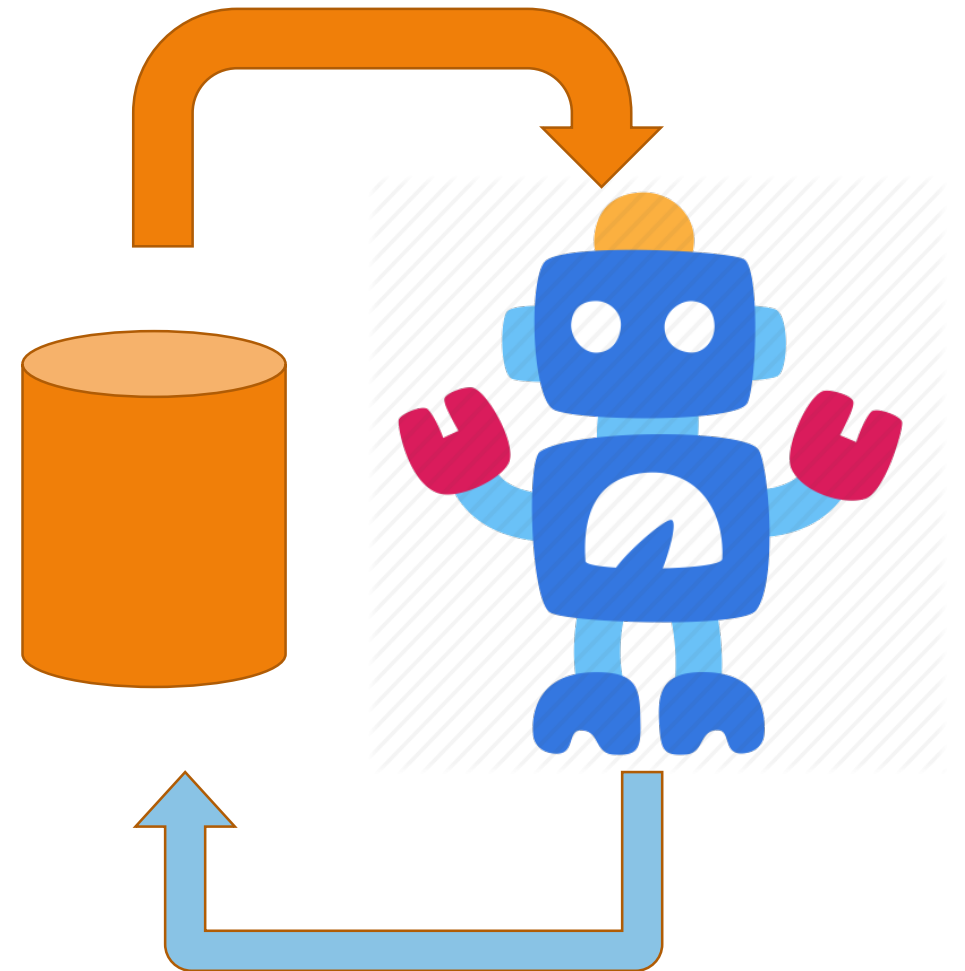
Strong

supported
Not directly

AI capability
Classification
Clustering
Pattern recognition
Reasoning
Search
Optimization
Knowledge representation
Behavior description
Learning
Autonomous behavior

Obstacles to creating hybrid models

- Retrieval and marshalling of data between BIM to AI modules
- Round-tripping of updates from AI module to BIM
- Event handling between BIM and AI modules
- Aligning structural and behavioral descriptions
- Harmonizing ontological terms.



DISCUSSION



BIM adoption Challenges

1. Cost of BIM implementation
 - awareness of benefits and ROI not readily apparent to firms;
2. Training of the personnel required
 - trained and skillful personnel not readily available;
3. Standardization of workflows involving BIM
 - e-submission for approvals, design collaboration, interference checking, procurement and construction, construction management, testing/checking/quality, quantity surveying/ payments/ billing, handover
4. Reluctance to change established workflows
5. Development of standard families of BIM elements accepted by the building industry
 - Singapore market is small with many foreign firms
 - Products sourced from many countries.



BIM adoption: Complexity

- Individual factors often interact and reinforce each other at the firm and industry levels, forming strong reinforcing loops
- Cost of BIM implementation makes the ROI not immediately obvious or convincing
- Introduction of new BIM workflows loses out to established traditional non-BIM workflows
- Lack of experience and success stories involving use of BIM discourage people and firms in investing in BIM
- Lack of a wide range of skilled people developing aspects of BIM
 - tools, templates, libraries
 - guidance, training and consultancy
 - makes BIM adoption in projects expensive, time consuming and risky

➤ *thus increasing cost of BIM adoption.*



BIM adoption: Addressing challenges

- Develop product libraries for architecture, structural, and MEP disciplines
- Enact standards
- Formalize a BIM execution plan for projects
- Ensure sufficient volume of projects using BIM to attain strategic goals
- Develop and raise levels of knowledge and skill in usage in the industry.



CONCLUSION

- Productivity improvement remains the key goal of Singapore's construction industry
 - However, supporting continuous productivity gains is a challenge
- BIM
 - key technology enabler to transform the industry and make it more productive
 - central to many new initiatives like DfMA, VDC, and IDD
 - increasingly being used with other technologies to create a digitalized built environment
- More capable hybrid BIM models
 - Combining BIM's strong geometric and spatial handling capabilities, with
 - AI's knowledge representation and reasoning capabilities.



Thank you!