

Annex A: Factsheet on Built Environment Industry Transformation Map (BE ITM)

1 Led by the Future Economy Council (FEC) Urban Systems (US) Cluster Sub-Committee¹, the Built Environment ITM was developed through extensive consultations and in close partnership with the industry, Trade Associations and Chambers (TACs), Institutes of Higher Learning (IHLs), unions and government agencies.



Figure 1: Since 2021, MND & BCA have engaged more than 2500 partners and individuals from industry, TACs, IHLs/students, unions and Government agencies (via large scale meetings, focus group discussions and one-to-one sessions) to gather feedback, hear out industry challenges and work together to co-develop the BE ITM.

2 COVID-19 and recent global disruptions have exacerbated many of the BE sector's vulnerabilities, particularly issues with supply chains, and manpower. While we continue to monitor the situation and extend our support towards firms' recovery, our conversations with industry partners reveal that firms have begun to recognise that collective transformation across the sector is crucial to emerge stronger. Thus, the Built Environment ITM builds upon the previous Construction and FM transformation plans, and focuses on a value-chain approach to seize opportunities for BE sector transformation:

¹ The FEC was set up in 2017 to support the growth and transformation of Singapore's economy for the future, including the development and implementation of the ITMs. It comprises 7 clusters, including the Urban Systems cluster co-chaired by Senior Minister of State Tan Kiat How and Mr Liam Wee Sin (Group CEO, UOL Group Limited), represented by members from industry, TACs, IHLs, Unions, Government agencies. The Urban Systems cluster oversees the Built Environment, Real Estate, and Security sectors, which are led by BCA, CEA, and MHA respectively.

Vision of the Transformed Sector

3 The vision for the Built Environment ITM is:

A **world class and resilient cluster**, that will strengthen Singapore's competitiveness as a Little Green Dot, comprising **global champions and value chain alliances offering innovative, sustainable, & in demand solutions**, and **quality jobs**, supported by a **competent Singapore core**.

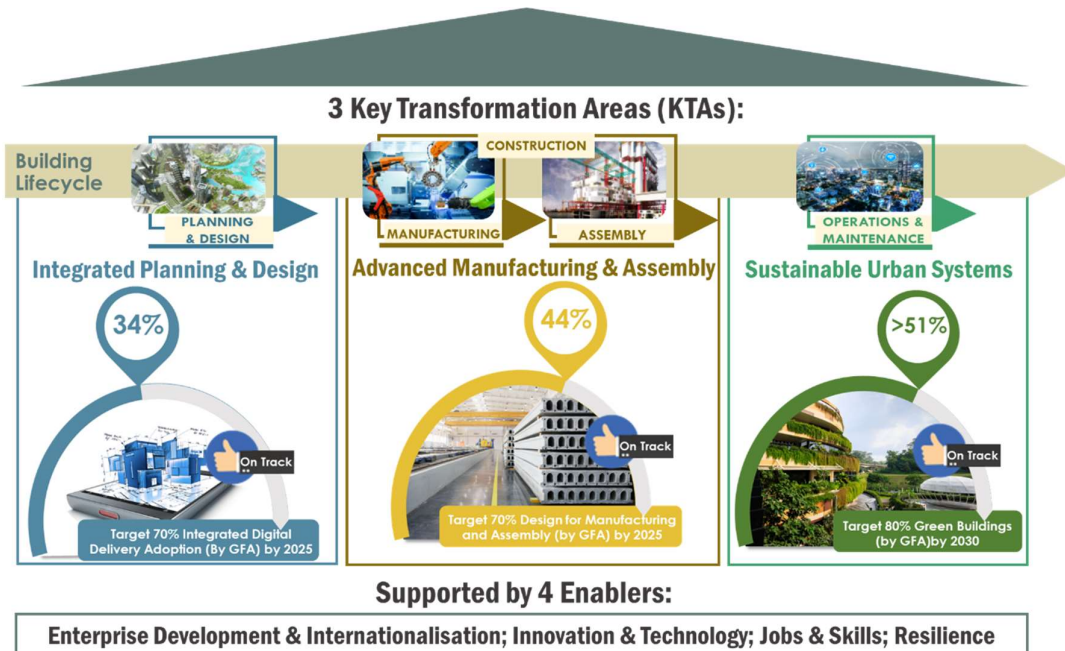


Figure 2: The 3 Key Transformation Areas (KTAs) and 4 Enablers under the BE ITM, which are elaborated below.

4 To achieve this, the strategies under the KTAs of the Built Environment ITM are:

Integrated Planning and Design (IPD):

- Facilitate the adoption of integrated Building Information Modelling (BIM) by project teams through CORENET X, which is envisioned as a one-stop digital shopfront for regulatory submissions across all regulatory agencies. CORENET X is slated for implementation in end-2023.
- Encourage the use of common data standards (i.e. Common Data Environment) to enhance collaboration, data exchange and communication for life cycle management of a project.

- c) Nudge industry towards progressive procurement practices such as collaborative contracting and early contractor involvement.

Advanced Manufacturing and Assembly (AMA):

- a) Enhanced Buildability Framework to make DfMA the default mode of construction, creating economies of scale that drive investment in robotics and automation, to increase productivity and reduce reliance on manual labour.
- b) Drive co-location of synergistic construction activities ² within Integrated Construction Parks (ICP) to optimise land use and streamline logistical processes.

Sustainable Urban Systems (SUS):

- a) Accelerate our transition to a low-carbon built environment to support our net-zero aspirations, through the latest edition of the Singapore Green Building Masterplan.
- b) Drive Integrated, Aggregated and Smart FM to prolong the lifespan of buildings, and better maintain our growing pool of infrastructure. (e.g. through the \$30M Integrated and Aggregated FM grant.)

5 The transformation strategies under the four enablers of the BE ITM are:

Enterprise Development and Internationalisation (EDI):

- a) Drive value chain transformation, with private and public sector developers taking the lead to build up highly capable, and resilient value chains (that may comprise consultants, contractors, specialised sub-contractors and/or FM providers), and develop competitive capabilities for the long-term.
- b) Distinguish better performers in tenders (e.g. through industry-led accreditation schemes) for projects, complemented by broad-based support measures for firms willing to transform.

² e.g. Aggregate/Steel terminals, batching plants, steel fabrication, integrated construction & prefabrication hubs (ICPHs), Prefabricated Prefinished Volumetric Construction (PPVC) fit-out

Innovation and Technology (I&T):

- a) Focus resources on high impact areas of research and capability-building, through identifying medium-to-long term sectorial I&T needs, and working with progressive firms, government agencies and Institutes of Higher Learning (IHLs) / Research Institutes (RIs) to build up research and innovation capabilities. For example, via Enterprise Singapore's new Centre of Innovation for Built Environment – Advanced Materials (COIBE-AM) that will provide dedicated support for SMEs and start-ups to accelerate the proliferation of innovative technologies. The industry may also tap on other I&T supporting programmes and develop relevant projects under the Cities of Tomorrow R&D Programme and the Built Environment Technology Alliance Programme (BETA).
- b) Strengthen the open innovation ecosystem to proliferate technology within the sector, by matching demand drivers to solution providers and providing fast-tracked support to resolve BE firms' areas of concern (e.g. through open innovation platforms like BEAMP). Test-bedding platforms and regulatory facilitation for innovative solutions are also available to enhance the chances of success in translating research outcomes to commercialisation and deployment.
- c) Drive mass adoption of market-ready solutions through broad-based support measures³.

Jobs and Skills (J&S):

- a) Identify in-demand job roles and redesign critical roles in tandem with a greater level of technology adoption and process re-engineering, to provide more fulfilling jobs in a better working environment.
- b) Raise adoption of Skills Framework and recognise its associated industry-led accreditation schemes in procurement, to create progression opportunities and better prospects for our professionals.

³ Targeted incentives include the Productivity Innovation Project that defrays the cost of technology and DfMA adoption, as well as Advanced Digital Solutions and Productivity Solutions Grant that support SMEs in adopting pre-approved productivity and digital solutions

Resilience:

- a) Working closely with the industry to strengthen manpower and supply chain resilience against future disruptions, learning from the experiences throughout the COVID-19 pandemic and recent geopolitical instabilities.

Firms to Take Charge of Industry Transformation, Supported by Government

6 Progressive value chain partners, firms, and GPEs are taking the lead to drive transformation and build up the BE ecosystem. We encourage more firms and individuals to embrace change, seek stronger collaboration across the value chain, and invest in grooming a competent, future-ready workforce.

7 As a start, firms should prioritise investments in innovation and technology, to build up competitive capabilities and better differentiate themselves locally and internationally. Concurrently, firms should review and redesign jobs and practices to create more meaningful jobs and better prospects for BE employees.

8 The Government will continue to provide targeted measures to support firms to adopt technology, build capabilities and upgrade their workforce.

Annex B: Factsheet on Collaborative Contracting

1 As part of the Built Environment ITM, a key work area is to encourage the entire value chain to collaborate and enable better planning and execution of a project. A less adversarial contracting practice will help to achieve this, by overcoming the issues often observed in the current conventional approach. For example:

- a) Lack of integration between the design and construction stages.
- b) Project team members will guard their respective contractual responsibilities and pass the risks to others. This overshadows common goals of the project.
- c) Issues are usually not resolved promptly, often left towards the end of the project which may potentially lead to disputes.

2 Collaborative contracting seeks to overcome the issues in traditional contracting. It encourages a mindset shift towards working collaboratively for the shared project goals. It helps parties to proactively identify potential issues, resolve these issues early, and better manage disruption and cost fluctuation especially if the market is volatile. The key principles and benefits of collaborative contracting are as follows:

Key collaborative contracting principles	Benefits
Acting in a spirit of mutual trust and cooperation	With trust, parties will work as a team to jointly resolve differences, challenges and have shared values to deliver their common project's objectives
Giving early notifications on potential issues affecting the project and joint problem solving	Parties identify potential risks early so that risks can be mitigated, and solutions are discussed and agreed upon, avoiding escalation as disputes
Adopting proactive project management approaches with clear timeline for (i) contractors to notify any event that will impact cost and timeline, and (ii) contract administrator to	With clear timeline, parties will be guided to promptly agree on claims and submissions instead of leaving them to snowball towards end of the project that may potentially lead to disputes

respond and evaluate claims and submissions	Proactive monitoring of progress and management of changes help to avoid straining of relationships
Structured dispute avoidance and resolution mechanism with the involvement of independent third party or Senior Management representatives	This helps to prevent disputes from escalating and preserve relationship between parties. It also reduces the costs associated with disputes
Establishing a fair and sustainable allocation of risk and alignment of project participants' interests based on project needs	Allows sharing of risk among parties through different payment mechanisms (from lump sum to pain share/gain share mechanism) and working towards common project goals

Annex C: Factsheet on Integrated Construction Parks

1 BCA has been working with URA, JTC and various industry stakeholders to plan Integrated Construction Parks (ICPs), located across Singapore to support the BE industry, focusing on:

- a) Optimising the efficiency of land use and transforming unproductive/ conventional production into advanced manufacturing with higher productivity and greater automation
- b) Streamlining of construction supply chain through co-location of related and synergistic facilities and activities

2 The ICPs will provide a platform for firms to develop their DfMA solutions and production facilities. Synergistic construction supply chain activities will be co-located within the park to streamline logistics. ICPs will also leverage advanced technology to make production more productive, greener and cleaner.

Jurong Port ICP



Photo Credit: Jurong Port



Photo Credit: Jurong Port

3 Jurong Port (JP) ICP, the first ICP, will be operational from December 2022. JP will co-locate key supply chain players within their port and form alliances. This will help develop a strong and collaborative supply ecosystem, strengthen domestic production capacity, and encourage investments in advanced technology to support the Built Environment ITM. The JP ICP will support the supply of cement, steel, ready-mixed concrete (RMC), concreting aggregates and PPVC/precast.

4 The key benefits of JP ICP include:

- a) Supporting Singapore's BE sector and fostering collaboration amongst firms:
 - i. Encourage firms to invest in synergistic solutions
 - ii. Opportunities for firms to collaborate by sharing of resources and common facilities
- b) Increase productivity through leaner construction supply chain
 - i. Co-location of concreting aggregates, cement and steel handling will enable a more efficient and greener construction materials supply chain
 - ii. Optimised land use with higher plant capacity
- c) Use of sustainable and green operation methodologies and technologies
 - i. Reduce carbon emission with fewer truck trips
 - ii. Equipped with technologies and shared facilities such as advanced sludge recycling systems and solar photovoltaic panels

- d) Manpower savings and enhanced quality control
 - i. Use of enclosed conveyancing system to transport aggregates
 - ii. Advanced production facilities and improved flow of materials

Annex D: Factsheet on Integrated Facilities Management (IFM) and Aggregated Facilities Management (AFM) Grant

1 Optimising building performance at the Facilities Management (FM) stage helps foster better sustainability outcomes, reduces maintenance workload for FM teams, and enhances their productivity. To demonstrate this, BCA has introduced a \$30 million IFM and AFM grant, which will co-fund up to 70% of the actual qualifying costs for the adoption of progressive FM procurement, processes and technologies.

2 The grant is open to projects aggregating across three or more existing buildings with a combined GFA of at least 45,000m² for the following building typologies:

- a) Commercial developments (e.g. hotels, serviced apartments, offices, retail buildings, mixed- developments, MSCT managed commercial and retail buildings);
- b) Institutional developments (e.g. healthcare facilities, Institute of Higher Learning campuses);
- c) Light industrial buildings; and
- d) Other building typologies with strong potential to contribute towards FM sector transformation, which will be determined by BCA in its sole discretion.

3 To qualify for the grant, both service buyers (i.e. developers, building owners) and Facilities Management Companies (FMCs) must collaborate closely as partners via a joint application to undertake the project and commit to the following eligibility requirements:

- a) FMC must be registered under BCA's Contractor Registration System Facilities Management (FM01)⁴ Workhead and accredited with at least a 'Gold' tier rating under Singapore International Facility Management Association's (SIFMA) Certified Facilities Management Company (CFMC) accreditation scheme;
- b) Adopt Outcome-Based IFM and AFM contracts that bundles 3 or more FM services together, consisting of at least 1 soft (e.g., cleaning, security,

⁴ Definition of FM01 Workhead: Provision of Integrated Facilities Management (IFM) and/or Managing Agent (MA) services by facilities management companies.

landscaping & etc.) and 1 hard FM service (e.g., Air-Conditioning and Mechanical Ventilation (ACMV) Systems, lifts & etc.) with a minimum contract period of 3 years;

- c) Perform a gap analysis⁵ based on the Green Mark: 2021 Maintainability Section Framework, for all buildings included in the proposal;
- d) Implement Type 3 Smart FM⁶ solutions which integrates across at least 3 FM services to optimise resource deployment;
- e) FMCs must complete Human Capital Diagnostic Tool (HCDT)⁷; and
- f) Demonstrate 20% or more overall productivity gains by manpower (e.g., man-days, man-hours, headcount, etc.)

4 A non-exhaustive list of Qualifying Cost Items are categorised into the Qualifying Cost Areas as follows:

Qualifying Cost Areas	Qualifying Cost Items
a) Design	Professional and consultancy services to carry out the Gap Analysis exercise based on the Green Mark: 2021 Maintainability Section Framework
b) Technologies required to achieve at least 20% overall manpower productivity gain	<ul style="list-style-type: none"> i. Subscription fees relating to the provision of telco services, cloud service and platform services ii. Purchase, installation and configuration of gateways, sensors, actuators iii. Purchase and configuration of analytics software (e.g. video surveillance, predictive maintenance)

⁵ "Gap Analysis" refers to assessing the degree of maintainability of the building's inherent design – via GM: 2021 - Maintainability Section – to understand design-related inefficiencies in its current maintenance regimes. This would help service buyers plan and evaluate short-term and long-term improvements, accordingly.

⁶ Applicable for Smart FM solutions that transforms FM service delivery to one that is outcome-based, on-demand or as-needed (rather than scheduled), enable fluid and optimal deployment of resources and where appropriate, integrates with autonomous technologies. Some key characteristics include, but not limited to, workflow automation, digitalisation of routine FM tasks, predictive or on-demand maintenance; dashboard to monitor, manage and report performance of the 3 integrated services, implement digital integration plan to FM subcontracting supply chain, etc. For more info, refer to the ["Guide to Smart FM"](#).

⁷ HCDT, a national framework for workforce optimisation that measures human capital in terms of its capacity to support business goals, outlines an action plan, and prioritises resources to optimise competencies, processes and practices;

	<p>iv. Subscription fees for a maximum of two (2) years or lease of equipment including computer hardware, robots</p> <p>v. Supply and installation of other equipment, materials, software and other physical or digital components of the proposed technology solutions as approved by BCA in its sole discretion</p>
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5 For interested service buyers and FMCs, you may complete the Pre-consultation Form. Our BCA Officers will contact you to arrange for a pre-consultation session. Please note that the pre-consultation does not constitute as a grant application. More information on the [IFM and AFM Grant](#) can be found on the BCA website.

Enhanced Guide to Smart FMs

6 The Integrated Smart FM Taskforce under the Facilities Management Implementation Committee (FMIC) developed the Guide to Smart FM which was launched on 1 October 2019. The guide provides Building Owners and FM Managers with an easy-to-use reference to guide them on the key steps to take in their smart FM journey. As the industry moves towards Integrated FM and Aggregated FM (IFM and AFM) adoption, the Guide has been revised to provide more guidance on Type 3 Smart FM processes, technologies, and digital skillsets. For more information, visit [Guide to Smart FM](#).

Annex E: Factsheet on the Growth Transformation Scheme

1 The Growth and Transformation scheme (GTS) supports value chain transformation efforts in the BE sector. This is a significant shift from project-based support schemes where stakeholders usually focus on implementing initiatives to deliver the project on hand.

2 To enable value chain transformation, the GTS supports initiatives undertaken by a group of firms that include progressive developers, consultants, builders, sub-contractors and specialist suppliers, to mutually support project parties to achieve common transformation outcomes. The key objectives of GTS are to:

- a) Groom a core group of strong industry leaders to drive industry transformation;
- b) Push the boundaries for best-in-class capabilities, and spearhead adoption of advanced technologies such as DfMA, IDD and Green Buildings; and
- c) Achieve transformative workforce development and business growth/strategic collaboration goals.

3 Over the past year, BCA has worked with the industry to refine the scheme further, including a set of outcomes that projects will need to meet as follows

- a) Each alliance, led by a developer and comprising at least one builder and one consultant, will develop a business plan of at least three years, detailing how the group of firms will work collectively to meet more ambitious targets under the BE ITM. This ensures that firms take a longer-term view on capability development and their working relationships.
- b) Strategic Collaboration: Alliances should look towards implementing collaborative contracting and project management. This could mean putting in place structured processes for regular progress reporting, early notification of potential problems and dispute resolution, to encourage all parties to resolve differences expeditiously in service of shared project objectives.
- c) Human Capital Development: Alliances are expected to actively implement workforce development initiatives to increase productivity across the value chain, retain talent and level up smaller players. For example, firms are required to complete Institute for Human Resource Professionals' (IHRP) Human Capital

Diagnostic Tool and implement initiatives to enhance their human capital practices.

- d) Productivity: Alliances are expected to deploy more productive methods of construction to achieve more than 30% (non-residential buildings) and 35% (residential buildings) increase in site productivity over 2010 levels.
- e) Sustainability: New buildings are expected to achieve Green Mark Platinum Super Low Energy with Maintainability badge. This will yield at least 60% improvement in energy efficiency over the 2005 industry average. Alliances will also need to attain at least 20% manpower savings from the deployment of advanced Facility Management technologies.
- f) Digitalisation: Alliances are required to take a more holistic view of digital transformation, supported by a good foundation in key digital use cases. They will work towards a 40% increase in productivity at the use case level, leveraging Common Data Environment data standards and integrating key functions such as procurement and contract management.

4 BCA will continue to work with interested developers on potential needle-moving initiatives under GTS and firm up the alliances in due course. For firms who want to find out more about the GTS, they may contact BCA.

Annex F: Factsheet on Built Environment Transformation Award

1 The inaugural Built Environment Transformation Award (BE Transformation Award) accords recognition to building projects that demonstrated commitment towards transformation. The objective of the Award is to spur firms to attain high standards in sustainability, productivity, digitalisation, and other attributes that support capability building, workforce development, innovation and resilience as aligned to the Built Environment ITM.

2 There are four Award categories:

- Residential Buildings
- Commercial / Mixed Development Buildings
- Industrial Buildings
- Institutional Buildings

Evaluation Criteria

3 The evaluation criteria for the BE Transformation Award are as follows:

Sustainability

- a) Level of Adoption of Green Mark Standards
- b) Adoption of Facilities Management Best Practices

Design for Manufacturing & Assembly / Productivity

- a) Demonstration of DfMA principles across Design, Manufacturing and Construction
Adoption of Technology (To achieve higher productivity or quality)
- b) Level of Productivity Outcomes (Time /Cost /Manpower savings)
- c) Attainment of Quality Standards (CONQUAS, QM tiered rating and score, managing DLP)

Integrated Digital Delivery

- a) Extent of Process Integration and Competency Building
- b) Adoption of Common Data Environment Data Standards
- c) Adoption of Innovative Digital Solutions

- d) Level of Outcomes and Measurable Improvements

Enterprise Development

- a) Project Owner's initiatives in strengthening project members' capabilities
- b) Contractor's initiatives in strengthening its value chain's capabilities

Innovation & Technology

- a) Adoption of innovation/technologies to improve project outcomes

Jobs & Skills

- a) Initiatives in upskilling in-service personnel
- b) Good human resource practices
- c) Initiatives in attracting talents into the industry

Business Continuity Plan / Resilience

- a) Project team's BCP to minimise disruption (Manpower & Materials)

Winning projects for BE Transformation Awards 2022

Category	Project
Commercial / Mixed Development	PSA Liveable City
Institutional	Eunoia Junior College
Industrial	JTC's 1 & 7 North Coast
Residential	The Tapestry

1) PSA Liveable City



Developer	Builder	Architect	C&S Consultant	M&E Consultant	ESD Consultant
PSA Corporation Limited	Lum Chang Building Contractors Pte Ltd	DCA Architects Pte Ltd	RSP Architects Planners and Engineers Pte Ltd	Surbana Jurong Consultants Pte Ltd	Surbana Jurong Consultants Pte Ltd

Project features

- The project attained Green Mark Platinum and put in place an Integrated Building Management System (iBMS) and Integrated Energy Management System (iEMS) to improve operational efficiency.
- Through the use of iBMS, the team noted a 30% reduction in chiller plant energy consumption and 60.9% reduction in Air Handling Unit energy consumption. There were also productivity improvements of 93.7% and 75% for power and water consumption monitoring respectively through their digital metre

interfacing. Additionally, the team observed a 33.3% manpower productivity improvement for lighting management via a centralised monitoring device at each floor.

- With the iEMS, the team expects a further 3.5% reduction in energy consumption of the chiller plant and 12.5% in manpower productivity improvement.

Extensive use of digitalisation and technology to improve productivity

- Successful use of Common Data Environment (CDE) platforms and structured data standard setup to facilitate data sharing and cross-disciplinary collaboration. With improved coordination between project team members, the team was able to identify issues in the design phase and improve productivity
- These data-sharing ecosystems create value as multi-disciplinary project team members can easily access project data through their smart devices, allowing the multiple stakeholders to streamline workflow, collaborate on designs in real-time and improve decision-making.
- Utilisation of drones for on-site surveillance, site safety monitoring and real-time façade inspection improved site safety monitoring by 45% and reduced façade inspection from 60 manhours to 20 manhours.

Good Workforce Development

- DCA Architects and Lum Chang are committed to upskilling and deepening knowledge of their staff in Industry Transformation areas and Leadership skills
- For example, DCA practices regular check-ins with staff to identify skill gaps, as well as invests in career development programmes to support individual learning paths and promote culture of lifelong learning, such as professional qualifications and accreditation, training programmes, and certification courses. About 40% of architects and 20% of BIM modelers in the firm took on new BIM / REVIT certifications between 2019 to 2021. Additionally, the firm frequently partners BCA on Industry Transformation-related programmes and holds IDD sharing sessions.

- Lum Chang has in place key competency development framework for their Engineers, Quantity Surveyors, and BIM Modellers, to help guide and chart out staff' career progression
- Lum Chang has participated in the iBuildSG Scholarship and Sponsorship Programmes since 2011, with 52 recipients having benefitted. There are currently 13 CONQUAS specialists, and plans are in place to send 17 more staffs to attain the CONQUAS certification. Lum Chang has also identified 21 qualified staffs to undergo the Construction Professional Accreditation Scheme (CPAS) to further their progression in time to come.
- DCA Architects and Lum Chang have been consistent in their talent attracting efforts. In DCA's case, the company sponsored 11 scholarship recipients since 2013 under the iBuildSG Undergraduate Scholarship and Sponsorship programme. The company also engages in direct mentorship on the job development for promising staff to push their careers forward.
- DCA also establishes meaningful partnerships with key stakeholder groups such as youths for engagement sessions. DCA provides sponsorships for various programmes, such the Graduation Prize Sponsorship for Sustainable Urban Design & Engineering with Ngee Ann Polytechnic. It also provides internship opportunities for polytechnic students, to develop youths' interests in BE areas and careers.
- In addition, the company has internal initiatives to boost staff welfare and morale, including implementing flexi-hours work schedule, pushing the work-from-home culture for non-operational staff and measuring staffs' performance by their quality of work and efficiency, rather than the total hours spent at work. This encourages a fair evaluation of performance and a better mental-health welfare for employees. Office furniture also got upgraded to help staffs' physical health. Lum Chang also took efforts to ensure wages remain competitive to attract and retain talent.

2) Eunoia Junior College



Developer	Builder	Architect	C&S Consultant	M&E Consultant	ESD Consultant
Ministry of Education	Kimly Construction	CPG Consultants Pte Ltd	CPG Consultants Pte Ltd	CPG Consultants Pte Ltd	CPG Consultants Pte Ltd

Innovation and Technology

- One of the first movers to adopt Cross Laminated Timber (CLT), Prefinished Modular Façade (assembly is done on site and larger panels can be hoisted by a Tower Crane thus overall installation productivity is improved) and CREE Hybrid Slab System (lightweight and able to bear heavier load, low carbon footprint) which led the project to achieve 44% productivity improvement over 2010 levels.
- Eunoia Junior College (EJC) is the first high-rise JC in Singapore. During the time of construction, there was no precedence in terms of fire safety for such high-rise CLT buildings. The team was able to mitigate potential fire safety issues by seeking SCDF and other authorities' compliance for performance-based design of MET (CREE Slab and CLT façade) and conducting real life

performance testing in Singapore. The new technology and collaboration helped the team learn and apply the knowledge to future schools.

- Due to the nature of the running track, which is elevated, the team faced challenges to find the best possible solution to build the track. Part of the foundation located in the Kallang River was optimised during the construction stage to minimise impact to biodiversity and disruption to the surrounding users/ community.

Design for Maintainability

- Collaborative design approach – Involvement of FM practitioners upstream meant that the team could identify potential maintainability issues at the design phase, reducing operational challenges in building maintenance after construction. In addition, abortive works downstream were reduced, leading to better overall project management and a higher quality end product. This also means improved maintainability and an overall longer lifespan for the building.

Good Workforce Development

- Both Kimly and CPG have been actively training staff in Industry Transformation areas. CPG has a 1-1 IGNITE Coaching Program, which is a 6-month talent development program to groom their talents. Kimly adopts BE Sector Competency Framework Development and a structured On-the-Job (OJT) blueprint development.
- Both Kimly and CPG are strong advocates in attracting local talents into the construction industry and have participated in various initiatives.
- Kimly was presented with the SkillsFuture Employer Award in 2021. The company is on the SGUnited Traineeships Programme and participated in Career Conversion Programmes.
- In adopting the CREE technology, the team had to make several trips to Austria to learn about the technology, which was new to Singapore at the time. The trips were learning experiences, as the team was able to exchange ideas with Austria companies and learn best practices in MET design/ construction.

- As a result, in addition to the collective knowledge that Kimly learnt from their partners they are now capable of embracing integrated planning to offer a holistic, natural and simple construction method to all those who want to break new ground in MET construction.

3) JTC's Developments in Woodlands North Coast - 1 & 7 North Coast



Woodlands North Coast Artist's Impression (Photo: JTC)

Developer	Builder	Architect	C&S Consultant	M&E Consultant	ESD Consultant
JTC	Lum Chang Building Contractors Pte Ltd	Aedas Pte Ltd	Arup Singapore Pte Ltd	WSP Consultancy Services Pte Ltd	Arup Singapore Pte Ltd

Woodlands North Coast (WNC)

- Singapore's new-generation work-live-play-learn mixed-use industrial estate comprising offices, business park, industrial facilities and residences
- Vibrant ecosystem of global and local SME manufacturers, academia and R&D institutions where ideas and technology are developed, prototyped, test-bedded and commercialised
- 1 North Coast is a nine-storey light industrial building that offers first-of-its-kind flexible space usage that allows businesses to house non-industrial functions and manufacturing operations under one roof.

- 7 North Coast is an eight-storey building for general manufacturing and generic industrial uses.

Use of digitalisation and technology to improve productivity

- Both buildings adopted extensive use of digitalisation and technology such as IDD and Common Data Environment (CDE) platform to improve overall productivity through data sharing and cross-disciplinary collaboration
- Successful use of CDE platform, FulcrumHQ, and structured data standard setup to facilitate data sharing and cross-disciplinary collaboration
- Extensive use of Integrated Digital Delivery (IDD) powered by FulcrumHQ for process integration from design to asset delivery and management
- Developed new BIM processes to integrate 3D model and cost-estimating software, CostX, for automated generation of progress payments. The 3D CostX Model allows the whole project value chain to visually verify and value the work simultaneously, as opposed to verification from hardcopy prints in a traditional submission
- Implementation of 5D Progress Claim to achieve an improvement of 34% in resource management.

Design for Maintainability

Through collaborative design approach by involving the facilities management practitioners upstream, the team identified potential maintenance issues at the design phase to make it easy to maintain after construction. For example, there is an access route for the entire building façade, making it easy to maintain in subsequent years, as well as the use of sturdier materials for outdoor furniture.

Strong partnership across the entire value-chain

- Main contractor co-developed solutions with their value-chain to incorporate better process integration.
 - For example, the rebar supplier leveraged BIM to generate a bar bending schedule (BBS) which was suitable for immediate use on their Computer Numerical Control (CNC) machine. This significantly increased the

productivity as time was saved during different stages of planning, ordering, fabricating and claiming

- Using Tekla, BBS were generated directly from the BIM and sent directly to supplier for fabrication. This eliminated redundant process and increased productivity by 30%
- Various stakeholders in the value-chain were also trained on the adoption of virtual reality, asset management standards and more.

4) The Tapestry



Developer	Builder	Architect	C&S Consultant	M&E Consultant	ESD Consultant
Bellevue Properties Pte Ltd (CDL)	Woh Hup (Pte) Ltd	ADDP Architects LLP	P&T Consultants Pte Ltd	Belmacs Pte Ltd	Building System and Diagnostics Pte Ltd

Project Features

- The project adopted PPVC and as a result, they were able to achieve 30% productivity improvement.
- The project team has also delivered outstanding Quality results, as seen by their Quality Mark (Star) and CONQUAS (Star) achievements.
- Green Mark Platinum

Strong sustained partnerships

- Project owner CDL played a key part in kick starting Woh Hup's PPVC journey through this project despite the latter having no PPVC track record at the time of the project.
- CDL recognised the challenges for contractors to climb the PPVC value chain and provided strong support to Woh Hup. One of the measures taken included going beyond the conventional construction payment method. CDL worked with Woh Hup to work out an advanced payment scheme for off-site PPVC modules and modules fitting, both of which were very capital-intensive. Both parties then worked closely to coordinate works especially during the challenging COVID-19 period, to maintain their workforce while building up the team's capabilities.
- CDL recognized Woh Hup's PPVC capabilities through the collaboration on Tapestry and this has led to more partnerships in PPVC projects including Whistler Grand, Irwell Hill Residences, and Tengah Garden Walk EC, where they employed productive construction methods including IDD by designing and planning digitally before actual construction. This has helped reduce cost and abortive works as revisions are clarified at the digital stage.

Good Workforce Development

- Upskilling their staff, actively bringing new talent to the industry
 - Mr Leong Ju Hua, who interned with Woh Hup during his undergraduate days, joined Woh Hup as a site engineer upon graduation. While on board the project, Ju Hua was given the opportunity to take charge of several blocks. He was instrumental in assisting the Project Manager with many aspects of the site's progress and delivering the project to the client. With proper on-the-job-training, Ju Hua matured and excelled, working his way up to Project Manager by the time the project was completed. He is now working on another PPVC project in Jiak Kim Road / Irwell Bank Road.
 - Mr Kelvin Lee from ADDP Architects was given the opportunity to learn DfMA technologies and IDD implementation throughout the life cycle of this project, together with the project stakeholders. He also submitted his

Professional Practice Examination (PPE) case study using The Tapestry, under direct supervision of his senior in the office. He is appreciative of ADDP's support through guidance and advice for his PPE. He was also given the opportunity to lead the project throughout the construction period. He is currently working on another PPVC project by CDL.

- Woh Hup is the recipient of the Best Employer Award in 2020 & 2021 (Kinetic) and 2021 & 2022 (The Straits Times), a recognition of the company's good HR practices.
- Woh Hup is supportive of scholarship programmes to bring local talent on board the industry. For example, Woh Hup supported 36 students under BCA-Industry Built Environment Undergraduate Scholarship since its formation in 1993, and further supported 4 students under the BCA-Industry Built Environment ITE/Diploma Scholarship since 2012. In 2017, BCA-Woh Hup iBuildSG Undergraduate Scholarship was established, and the company has supported 14 students under this programme.
- As digital tools were used, Woh Hup provided hands-on training for their subcontractors to upskill their BIM capabilities. Levelling up their subcontractors meant that they would have a steady competent workforce for future projects as the industry moves towards digitalisation.