McKinsey & Company

The next normal in construction

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Serves clients across Europe, Middle East and the Americas, along the construction ecosystem, as well infrastructure and energy sectors

Experience across strategic and operational topics, including performance transformation, digitization, risk management

Author of several publications on the construction sector, including for example *The next normal in construction* (2020); *Artificial intelligence: construction technology´s next frontier* (2018), *Reinventing Construction: a route to higher productivity* (2017)

Industry leaders believed in a radically different ecosystem already pre Covid – crisis set to accelerate transformation

Pre Covid

90%

Believed that the **industry needs to change now**, and that need was more acute than 5 years ago

80%

Believed the industry will look **radically different** in 20 years

Today

2/3

Believe **Covid crisis will accelerate industry transformation, and…**

+50%

…have already increased investments to adopt to the Next normal

Where is the industry now?

Market characteristics	Industry dynamics
Customer demand Strong yet cyclical and fragmented demand with bespoke customer requirements	**A project-based building approach**
Construction inputs and characteristics Complex nature of construction and logistics, high share of manual work on site, and low barriers to entry	**A highly fragmented ecosystem**
Market rules and regulations Extensive and local regulation with lowest price tendering rules	**Misaligned contractual structures and incentives**
	Use of contractors and temporary staff

Outcomes

Lagging productivity growth	**1.0%** per year 1995-2015 vs. ~2.8% for the total economy
Slow innovation and digitalization	**Among least digitized** industries in the total economy
Low profits and high risks despite strong and stable growth	**4-5%** avg. EBIT margins for companies over last 20 years
Low customer satisfaction and regular time and budget overruns	**80%** typical budget overrun of large construction projects

New industry dynamics are emerging

Changes in Market Characteristics

Demand
Increasing complexity
Sustainability
Customer preferences (digital projects and digitised assets)
Modular

Supply
Skilled labour shortage
Changing worker preferences

Regulation
Stricter and more complex
Move to net zero

New industry dynamics

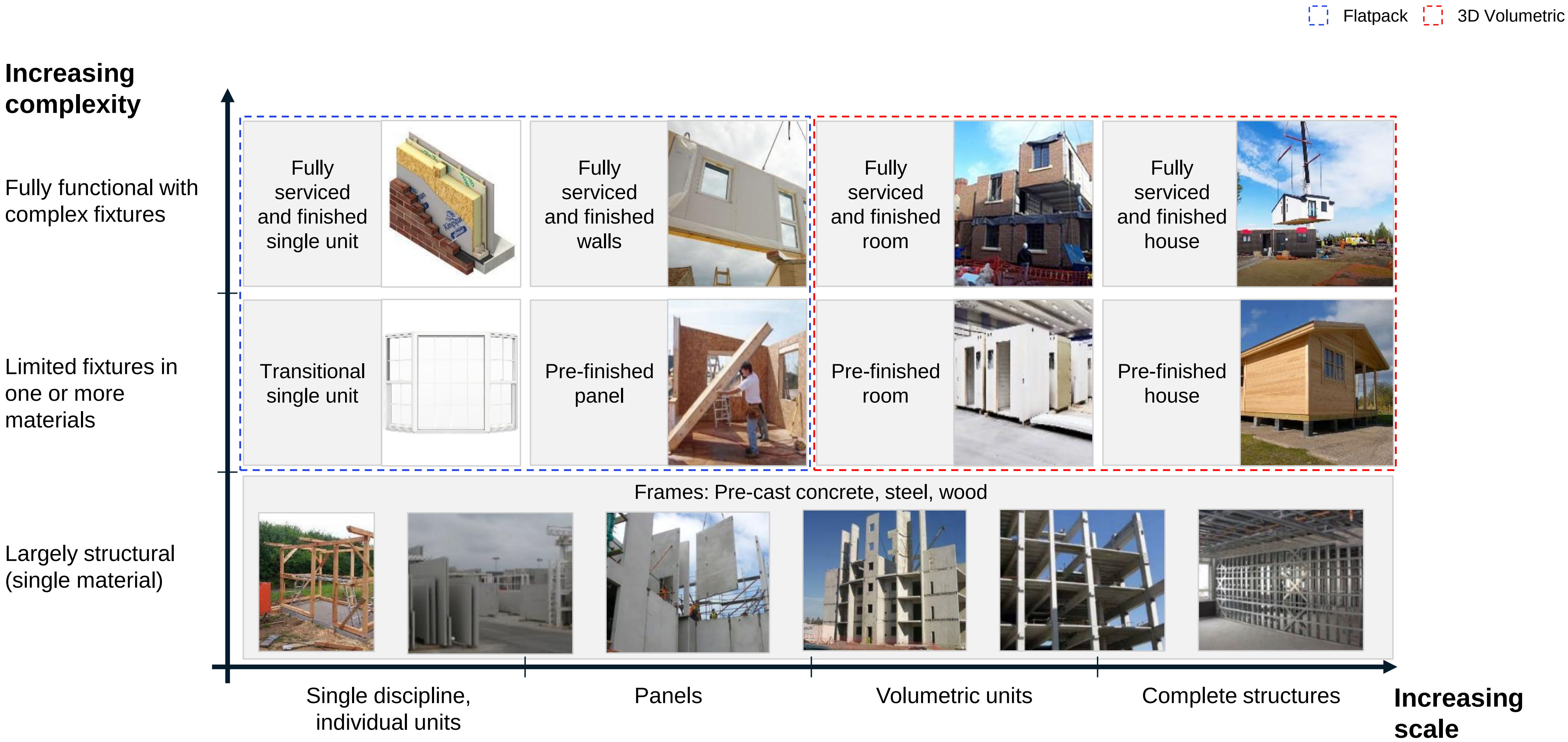
Emerging Disruptions

Industrialization
Modularization and product standardization
Industrializing workflows from engineering to planning and procurement/SC management
Automation

Digitalization
Lower barrier to entry (cost and complexity)
Thousands of new applications
2x increase in inbound investment

New entrants
Unicorns and startups with new business models
9% increase in M&A

Modular construction will lead to more industrialization



SOURCE: Interviews, case studies, literature review

A project’s specific requirements will determine the choice of modular system

More 2D panels ← → **More 3D volumetric**

Decision factors

Design flexibility & optimized logistics

Standardization, repeatability, cost reduction

Example projects

High-quality single family housing Potential solution: fully-fitted 2D panels

School or prison project Potential solution: hybrid 2D & 3D

Suburban affordable housing Potential solution: entire building

High-rise on precast concrete Potential solution: fully fitted panels & concrete frame

Low/mid-rise apartment building or hotels Potential solution: 3D modules

Example players

blueprint robotics, HUF HAUS, KATERRA, LINDBÄCKS, CNBM, BO KLOK, SEKISUI HOUSE, BARCELONA HOUSING SYSTEMS, CHAMPION MANUFACTURED BEAUTIFULLY, VISION MODULAR SYSTEMS UK LTD, POLCOM MODULAR, GUERDON MODULAR BUILDINGS, ilke HOMES, Skender

What are the benefits of modular construction?

Schedule compression by 20-50%	**Cost reduction** currently low, but could reach up to 20-40%	**Reliability** on cost and schedule	Competitive **quality of manufactured product**	Long-term **sustainability** and building opex savings

With the exception of the Nordics, offsite prefabricated homes currently occupy a small market share of residential construction

Affordable housing | Single family homes | Multi-family buildings

Title	Current offsite share of housing, %	Primary frame material	Primary housing segment	Major players
Nordics	45	Timber	Single family homes, Affordable housing	LINDBÄCKS, BO KLOK
Japan	15	Steel	Single family homes, Multi-family buildings	SEKISUI HOUSE
Germany	10	Concrete & timber	Single family homes	WeberHaus, GOLDBECK
China	6	Concrete & steel	Multi-family buildings	CNBM, BROAD GROUP 远大科技集团
Autralia	5	Timber & steel	Single family homes, Multi-family buildings	PREBUILT, Hickory
UK	5	Concrete & steel	Affordable housing, Multi-family buildings	LAING O'ROURKE, RAD URBAN, ilke HOMES
US	3	Timber & steel	Single family homes, Multi-family buildings	blueprint, KATERRA

1 Prefabricated housing share of all 1+2 family housing, note that in Sweden it has been reported that 84% of new homes are built using offsite methods | 2 Offsite construction share of all new housing | 3 In Germany 9% of new residential building permits are for prefabricated buildings, rising to ~20% of all 1+2 family homes | 4 Offsite construction share of all new housing

SOURCE: Prefab Housing (Matthew Aitchison); interviews; curbed.com; 5 in 5 Modular Growth Initiative (Ryan Smith); Roland Berger; Ministry of International Trade and Industry (Japan)

Modular construction in Europe and the United States could deliver annual savings of up to $22 billion and revenues of $130 billion by 2030

Suitability for modular construction: High (green) | Medium (yellow) | Low (red)

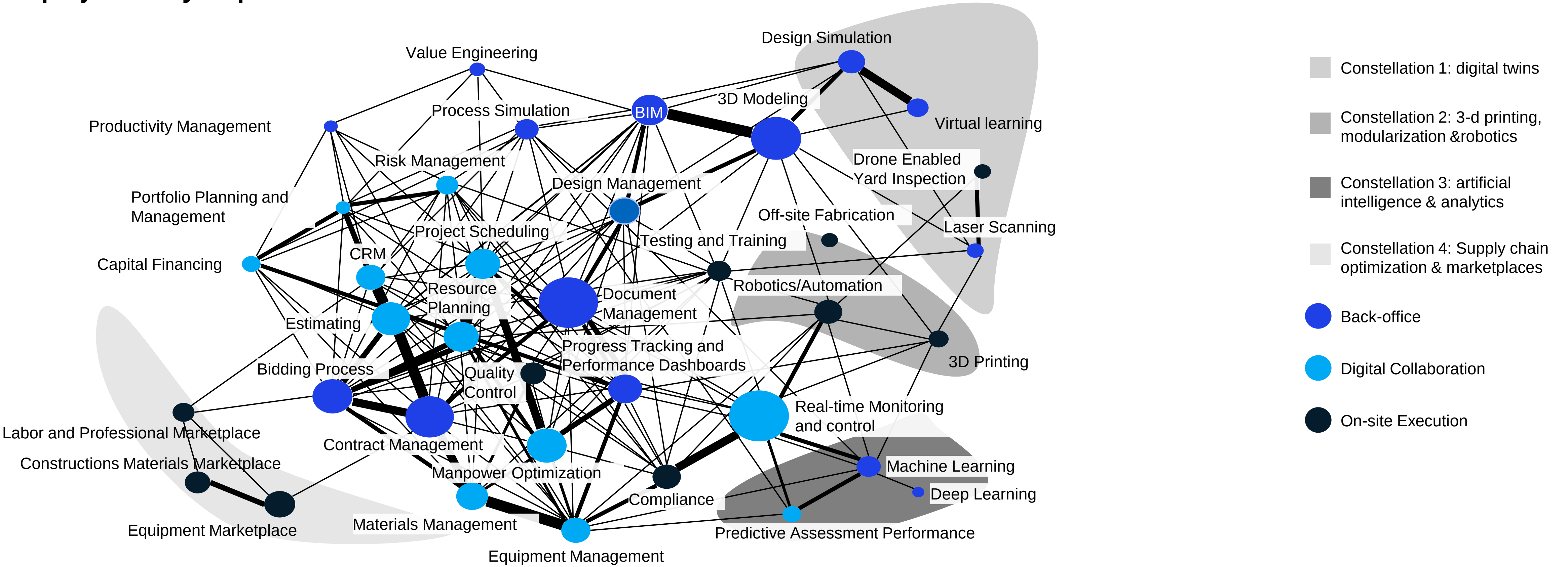
			Construction expenditure[2] $[8] bn, 2017	Additional addressable volume[3]	Market potential, $ bn	Savings potential[4]	Savings volume, $ bn	Rationale: Repea-tability[5]	Rationale: Unit size[6]	Rationale: Value density[7]
Buildings	**Residential**	Single family	376	◔	30	◕	5	Low	Medium	Medium
		Multi family	277	◑	45	◕	6	Medium	High	Medium
	Commercial	Office buildings	77	◑	10	◕	2	High	Medium	Medium
		Hotels	40	◕	10	◕	2	High	High	High
		Retail	42	◑	5	◑	1	Medium	Low	Medium
		Logistics/ Warehouse	46	◕	10	◑	1	High	Medium	Medium
	Public	Schools	59	◕	15	●	3	High	High	Medium
		Hospitals	41	◑	5	●	1	Medium	High	High
	Other buildings		70	◔	5	◕	1	Medium	Low	Medium
Buildings total			**1,027**		**135**		**22**			

1 Countries included: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, UK.
2 Includes only new building projects. Renovation/maintenance projects are less suitable for modular construction, but offer other productivity gain potential.
3 Informed estimates. A full moon corresponds to a potential construction project value for (additional) modular construction of ~30%, a quarter moon thus to ~7.5%, in 2030.
4 Informed estimates. A full moon corresponds to savings potential of ~20%, a quarter moon thus to ~5%, for each € of addressed construction expenditure.
5 No unique layout requirements (either from regulation, or design expectations). | 6 Small unit size allows standard transportation. | 7 High complexity of units, high share of wet rooms, etc.
8 Used 2017 average annual exchange rate to convert to $ from Euroconstruct data in €.

SOURCE: Euroconstruct; McGraw-Hill

New digital solutions landscape - significant value for the industry

All project lifecycle phases ~2400 firms



Note 1: Mapping during 2018 was focused on the full project lifecycle vs. construction phase in 2017
Note 2: Thickness of the lines corresponds to solutions that address more than one use case

Construction 6.0: A suite of 'here-and-now' technologies is available for deployment through vendors and contractors

Connectivity and sensing · Robotics and automation · Process digitization · Advanced analytics

IoT for tracking materials, machine and manpower

Optimizes facility run settings to maximize profitability and predictive maintenance minimizes down time

Digitized commissioning and handover

Digital punchlisting and handover

Drone-enabled LiDAR and laser scanning

Capture precise quantities and identity as-built errors

Digital field productivity tools

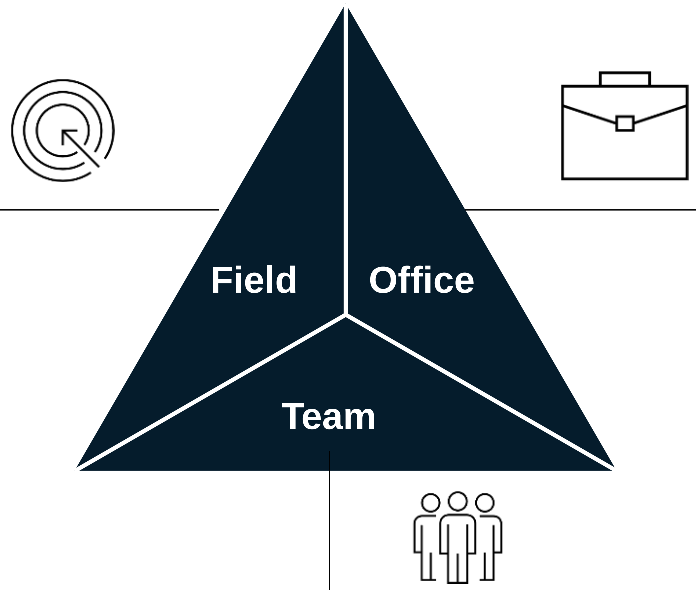
Helps connect foremen With crews, enabling day to day task management, productivity tracking and workface scheduling

Autonomous guided vehicles

Transport personnel, equipment and materials across site

Prefab/Modular & PPVC

Complete activities more productively, accurately and safely than humans



Digital collaboration and workflows

Achieving the paperless project, with digital workflows for all core project processes

Digital control tower, with predictive AI

Project leadership and site managers assess performance, anticipate issues, and develop action plans

Digital capital portfolio management

Specialized software, and advanced analytics, optimize capital investment and portfolio management

AR/VR/Mixed Reality for design

Operations staff review facilities and identify hazards during design

Generative design

Enables rapid concept and design option comparison and assessment

50 BIM and Digital Twinning

Adds additional dimensions to support operations and make better decisions

Construction technology is evolving fast, with 2 categories of players emerging

Platform players are trying to own data, with applications across the value chain

End-to-end design and construction integration between players using 5D BIM and digital twins

Design | **Construct** | **Operate**

An ecosystem of task-specific startups and unicorns is blooming

Supercharge design
- Automate simple/repetitive design
- Optimise designs using generative tools
- Design once, manufacture 100 times

Simulate the future
- Predict delays ahead of time using advanced analytics
- Increase accuracy of scheduling
- Simulate construction in safety-critical/complex areas

Get connected and organised
- Simplify and automate workflows
- Accelerate/automate approvals and payments

Drive front-line productivity
- Push punch lists to front line staff
- Track materials and plant
- Keep site staff safe (geofencing)

Be everywhere, all the time
- Track progress real time
- Build as-built digital twin

Augment human labour
- Exoskeletons
- Autonomous plant
- 3D printing

We observe new archetypes of players emerging

Archetype	Strategy	Example
Data-driven asset developers/ operators	Optimize end user value with minimal capex/ opex	wework
Integrated design-manufacturers	Offsite and standardized production of modules, in particular for hotels, resorts, apartments and student accommodation	POLCOM GROUP
Tier-1/ tier-2 material suppliers	Producing sub-systems for manufacturers as well as the refurbishment aftermarket –whitelabel and branded – optimized for manufacturing/ constructability	GEBERIT
Lean executors	Assembling assets on site with own or 3rd party/ platform staff but strong digital supply chain integration and site management	HusCompagniet
Specialized engineering-construction firms	High-value structures difficult to productize	KELLER
Online supply chain managers	Distributors with digital supply-chain management just-in-time-to-the-floor	solar
E-commerce platforms for construction	Homebuilding retail networks based on an online marketplace for building materials	LafargeHolcim

In particular in modular, many new players starting or scaling up – examples

	Description
RAD URBAN	Manufacturer of Steel-frame modules used in mid and high rise bases (up to 40 floors), particularly for hotels – ability to install up to 8 modules a day
Skender	Fully integrated contractor/ supplier for real estate – with in-house designer and manufacturing capabilities
LINDBÄCKS	Designer and engineer of wooden-frame apartments (~2500 / year); leveraging standardized production and customized architecture
POLCOM GROUP	Offsite and standardized production of modules, in particular for hotels, resorts, apartments and student accommodation
GOLDBECK	Simple structure with mass customization, supported by planning and architecture capabilities
KATERRA	Provider of designed systems leveraging a standard kit – an integrated platform supporting projects from design to assembly

Disruption is already happening

Shifts in the industry	Share of respondents in a survey believing that a shift is probable to occur at scale	Other supporting evidence			
Product-based approach	77%	51%	Growth in modular construction market share of total permanent real estate construction starts in North America 2015-2018	2.4x	Growth in permanent modular construction revenue in North America 2015-2018
Specialization	75%	BILFINGER	General contractor having specialized in the industrial segment after divesting civil engineering and real estate operations		
Value chain control and integration with industrial-grade supply chains	85%	64%	Average share of M&A volume for construction companies with target company in non-E&C business but within constriction ecosystem for 2017-19, compared to 31% for 2009-11		
Consolidation	82%	9%	CAGR in global construction M&A volume 2011-2017 (vs. ~7% for the global economy)	+100	Average # of additional deals per year 2014-2017 vs. 2009-2014
Customer centricity and branding	83%	hbreavis	Office real estate developer with highly people-centric approach – e.g. 60+ rewards since 2015		
Investment in technology and facilities	86%	77%	Increase in construction R&D spend 2013-2017 (vs. 36% for total economy)	40%	CAGR in construction tech funding 2012-2018 (vs. ~27% for the total economy)
Investment in human resources	74%	75%	E&C companies in the US have made changes to training and development program in the last two years		
Intenrationalization	75%	~12%	International revenue growth of top 10 construction companies globally 2013-2018 (vs. -3% in domestic revenue growth)		
Sustainability	90%	30% by 2030	Improvement target for energy intensity per sq.m. of the building to meet Paris agreement climate goals		

Effects will accelerate industry disruption

i

Increased digitalization and investments into technology

ii

Rebalancing of supply chains towards resilience vs efficiency

iii

Accelerated consolidation

iv

Increased vertical integration

v

Increase in offsite construction

vi

Acceleration in demand for sustainability

The construction industry expects sequencing of shifts similar to comparable industries

Transformation journeys in comparable industries have typically followed the same pattern
Length of phases highly indicative

Ship-building
~15 years

Commercial aircraft manufacturing
~25 years

Agriculture
~40 years

Car manufacturing
~40 years

First main change wave–industrialization, 20–25 years

- Value chain control and integration with industrial-grade supply chains
- Customer centricity and branding
- Shift to product-based
- Investment in human resources
- Investment in technology and facilities

Second main change ware–scale, 10–15 years

- Specialization
- Consolidation
- Internationalization

Sustainability

Construction industry practitioners expect a similar transformation journey
Share of respondents in a survey of 400 industry CxOs on expected timing of shifts in construction, %

First expected main change wave–industrialization

	1-5 years	5-20 years
Sustainability	79	21
Customer centricity and branding	74	26
Investment in human resources	74	26
Investment in technology and facilities	72	28
Product-based approach	71	29
Value chain control and integration with industrial-grade supply chains	71	29

Second expected main change wave–scale

	1-5 years	5-20 years
Specialization	65	35
Consolidation	57	43
Internationalization	57	43

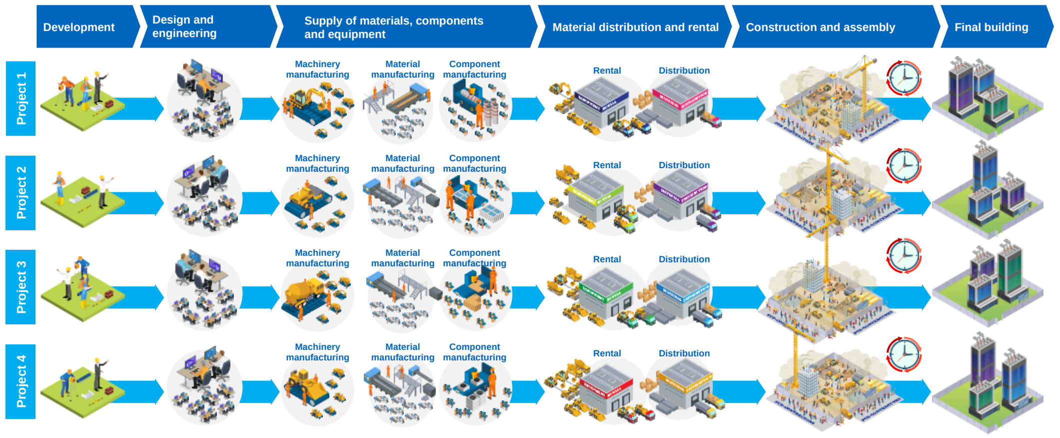
Sustainability shift to occur sooner in the transformation of the construction industry

Source: Survey of 400 industry CxOs, expert interviews, team analysis

Future construction ecosystem will be radically different

Construction Ecosystem Today

A highly complex, fragmented and project-based construction process…



The construction process is highly **project-based** - developed from unique customer specifications, designs **planned from scratch**, with limited degree of repetition

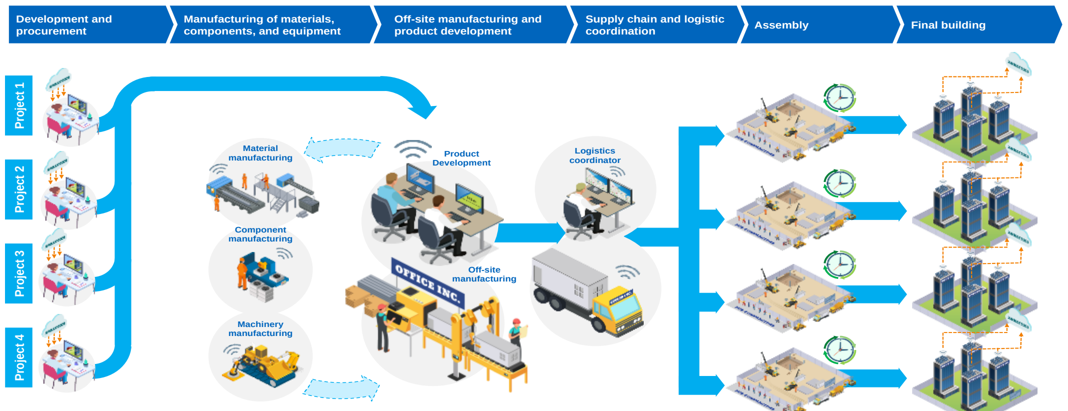
The value chain and the player landscape is **local and highly fragmented vertically and horizontally** with multitude of players involved at each step and major interface frictions

Construction is performed by generalists **on site in hostile environments**, with high share of temporary and **manual workforce**

Limited use of **end-to-end digital tools and process** and capital-light approach in delivery

Construction Ecosystem of the Future

***…**A more standardized, consolidated and integrated construction process*



The construction process is increasingly **products-based**, where structures will be products, manufactured off-site by **branded** product houses **specialized** in certain end user segments

Developers choose **entire designs or specific components** from a **library** of options developed inhouse or offered externally on the market

More **consolidated value chain both vertically** (delayering) **and horizontally**, with increased degree of **internationalization**

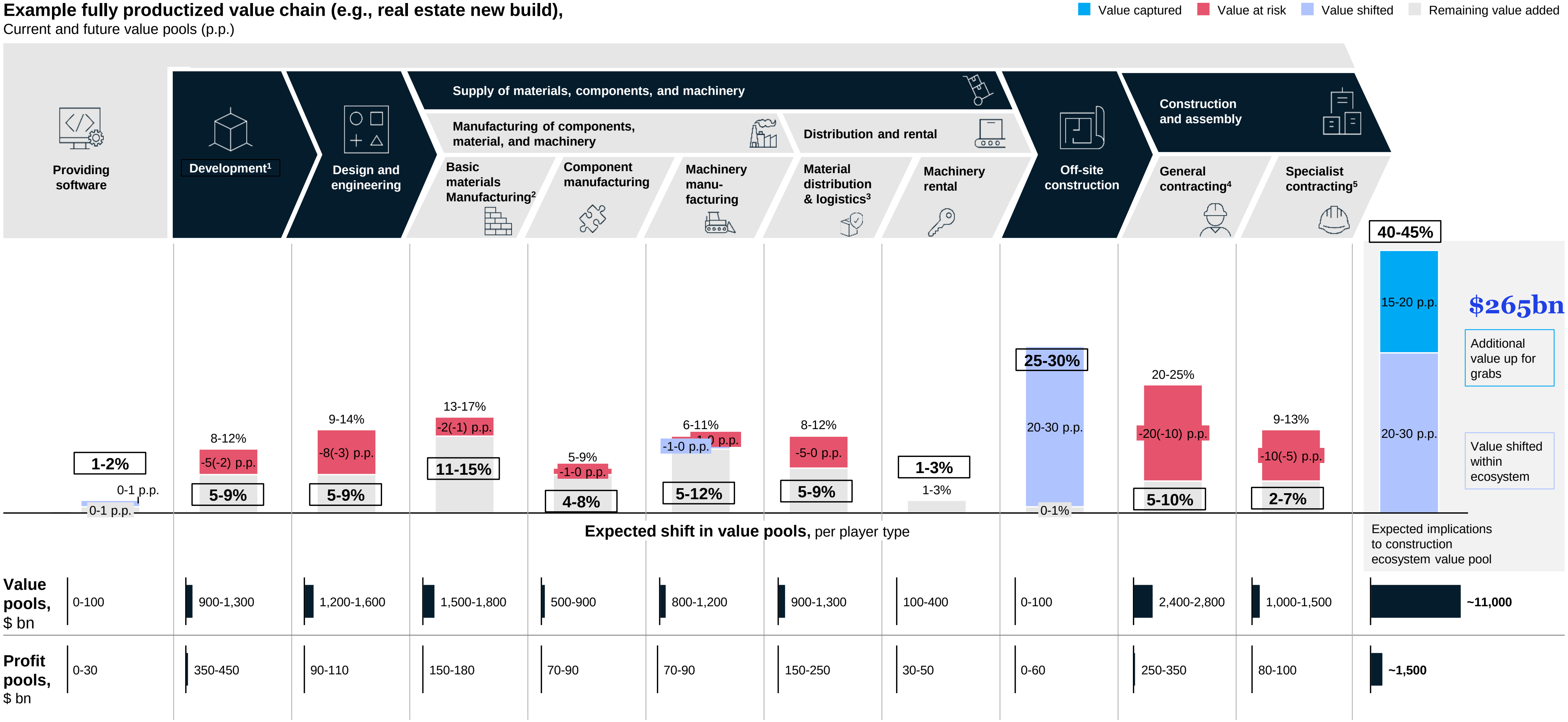
Disintermediation with use of digital marketplaces and direct channels

Contractors focus on **lean, on-site, execution and assembly of products**

Data and analytics on customer behaviour generated after completion to optimize TCO and future designs

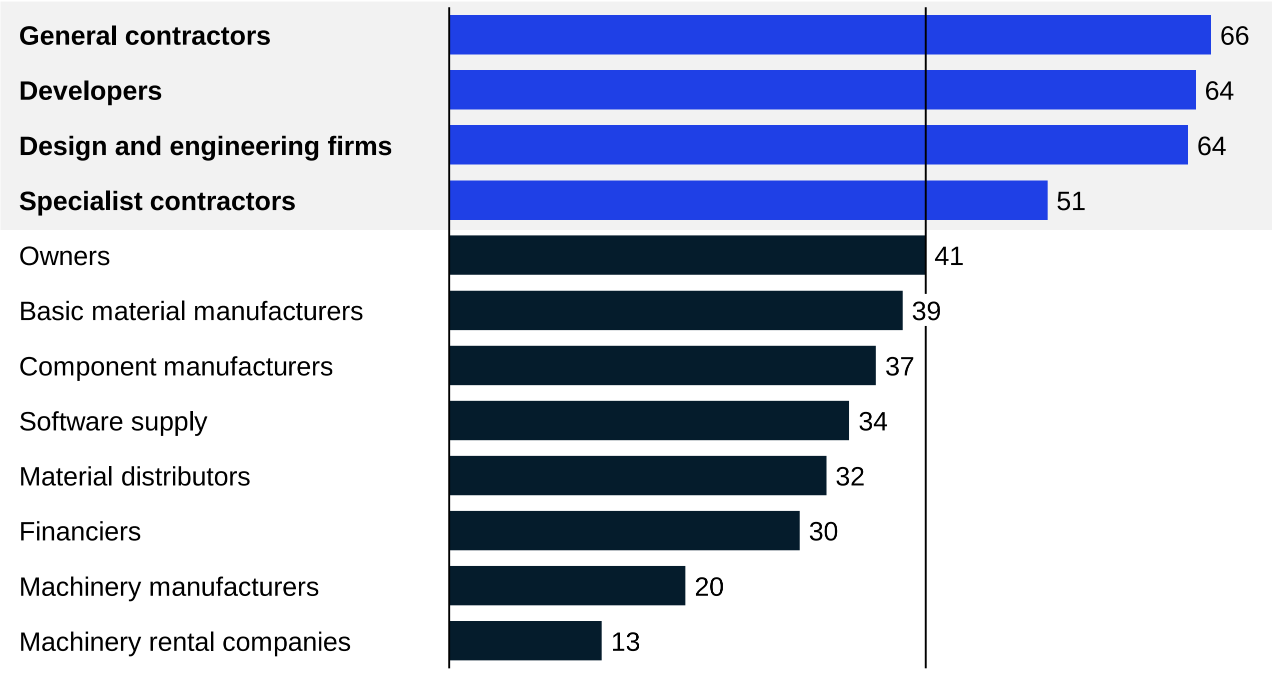
40-45% of value at stake in most affected segments

Example fully productized value chain (e.g., real estate new build),
Current and future value pools (p.p.)



Industry consensus is that General Contractors will see greatest change

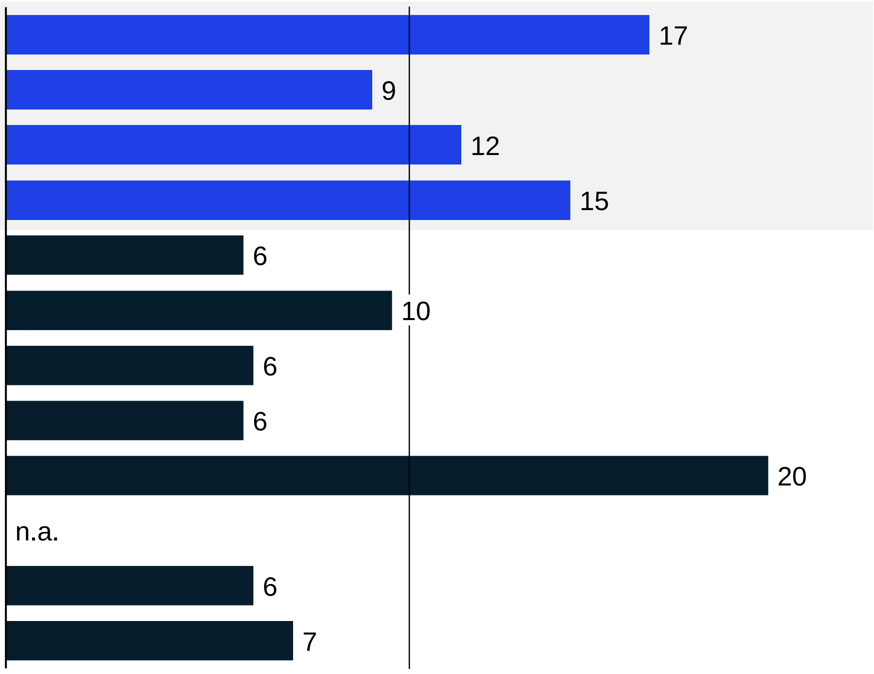
Which players in the value chain do you think will be required to change their way of operating first to adjust to the new construction industry landscape?
Share of respondents rating player types as “required to change first”



Average: ~38%

2/3 of respondents believe that general contractors, developers, and design and engineering firms will be required to move first

Which type of E&C player do you think will see the largest decline in 10 years (or even stop existing)?
Share of respondents rating player types as ”will see the largest decline (or even stop existing)



Average: ~13%

20% of respondents believe that material distributors will see the largest decline (or even stop existing) in 10 years

N = 400 - whereof 63% real estate, 19% infrastructure, 18% industrial | 47% North America, 39% Europe, 11% APAC, 2% Middle East and Africa, 2% Latin America

Significant implications for all stakeholders

Modular manufacturers

Scale and optimize

Developers

Productize and partner

Materials suppliers

Prepare for a shift in materials and go-to-market

Public sector

Bundle pipelines and update building codes

Engineering and construction firms

Preempt commoditization by delivering NextGen Projects

Investors

Understand the development to seek alpha

Preempt commoditization by delivering NextGen Projects

NextGen Projects aspiration

Take less **time & cost** to deliver

Have safe and **predictable outcomes**

Be **repeatable, continually improving** and **sustainable**

E2E V**alue maximization for all stakeholders**

Key themes to deliver NextGen Projects

Industrializing Project Delivery

- **Modularization, standardization, off-site construction, Automation**
- **Systematizing & Standardizing all Flows** i.e, Business development, Engineering, Procurement, Product Production Management

Digitizing Project Delivery

- **New operating system, unified technology platform**
- **(Real Time) Data-driven decision making and E2E reporting**

Upgrading the Operating Model

- **Agile at scale fostering collaboration and flexibility**
- **Capability building & re-skilling, new talent models**
- **Shift in culture and mindsets to adopt new ways of working**