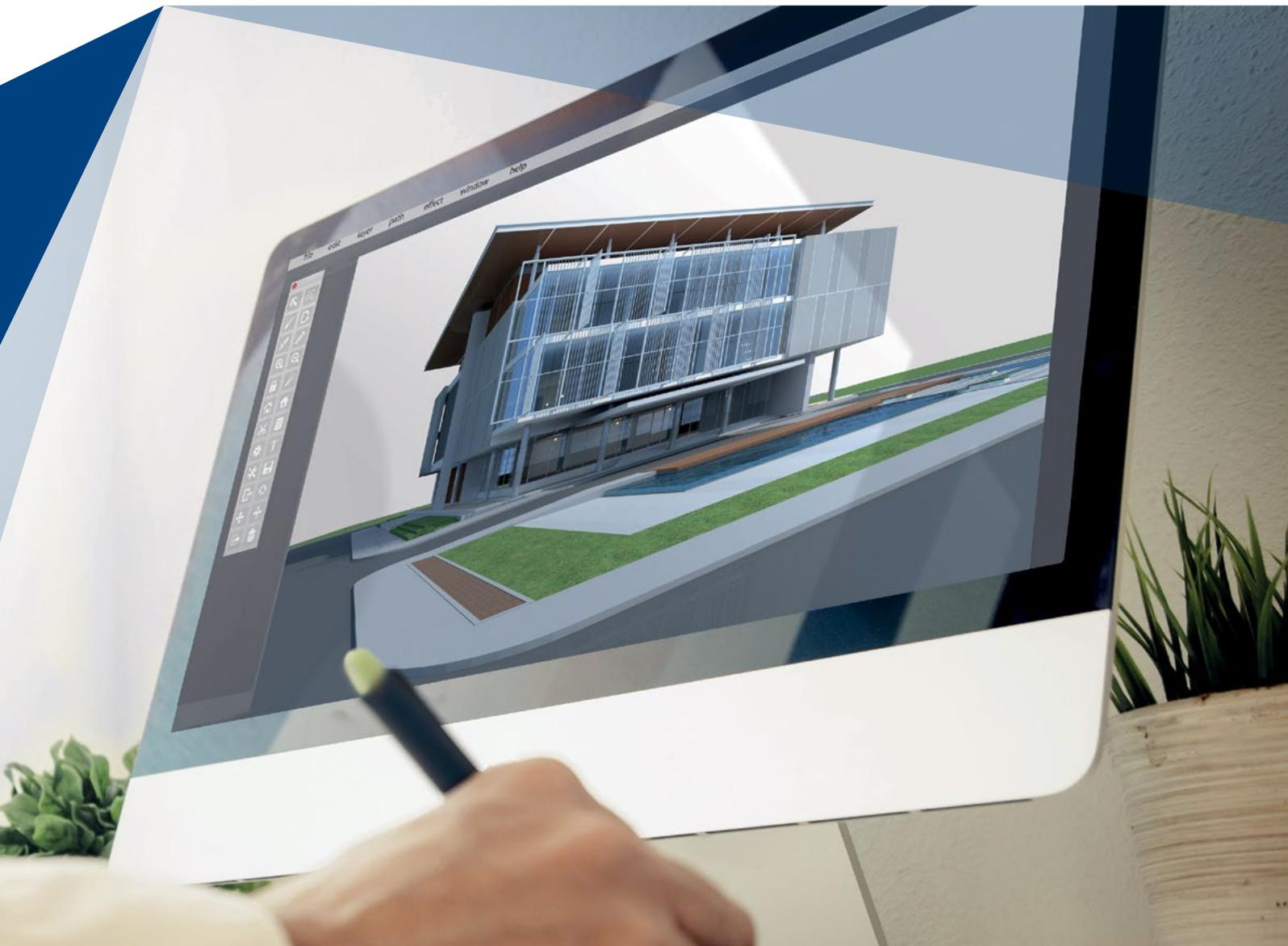


DIGITALIZATION OF THE CONSTRUCTION INDUSTRY: THE REVOLUTION IS UNDERWAY



THE TIME IS RIGHT TO SET UP A REAL DIGITAL STRATEGY IN CONSTRUCTION

Launching a real digital strategy becomes essential for continuous success in the years to come

INTRODUCTION

The formerly so called “brick and mortar” industry is entering the digital age. The digital push is accelerating and even if construction industry players are still confused and hesitant about the change and new technologies, the time has come for them to develop a real digital strategy. Many players have created innovation labs and launched “proof of concept” (POC) explorations, often through local business unit initiatives, to test possible options and to remain open to possibilities without investing too heavily. Those local experiences are not sufficient anymore to ensure success in the future and to be on top of the wave for the years to come.

It is important to note that while the necessary digital evolution can be a threat if not approached properly, it is mainly a land of opportunities both regarding cost efficiency, as well as regarding top-line client experience improvement and offer differentiation. Market player positions and values will be deeply impacted if today’s leading players don’t catch the ball in time.

DIGITALIZATION IN THE CONSTRUCTION INDUSTRY HAS BEEN A GROWING TREND FOR MANY YEARS: HOWEVER, NOW ITS SPEED IS ACCELERATING

The Construction Industry is reshaping itself, albeit slowly but certainly faster than previously. **Pressure for change** is coming from several complementary directions:

Evolving client expectations

Clients, influenced by other rapidly changing markets (such as B2C with platforms that have triggered new relationships, tailored products and powerful service levels), now expect also the same from their homes, offices, commercial buildings and infrastructures to make their “connected lives” even more a reality. Constructions need to be more and more individualized, modular, connected to the Internet of Things (IoT) and allow for specific performance tracking, optimization of energy and improved security and health parameters for instance. Client demands are quickly rising and become more and more complex with expectations increasingly on the “usage” more than on the product itself. (See Exhibit 1.)

New technological capabilities

Sensors and various hardware as well as software have seen cost drop and efficiency rise over the past few years opening the path to new possibilities. Technologies available on the market are more numerous than ever before (such as virtual and augmented reality, drones, robotics and additive printing) making it urgent to separate the more valuable ones from mere novelties.

New generation of craftsmen and professionals

Tech savviness is spreading in the construction industry, which traditionally has been, resistant to change, accelerating the adoption of digital tools. Innovative university curricula are training the younger generations for emerging tech-related jobs. Many new jobs, not yet known, will be created in the years to come with the adoption of new tools and processes.

Booming start-up environment

Startups have taken advantage of the market opportunities induced by some of these trends to fill newly created added-value gaps. Oliver Wyman has identified nearly 1,200 startups worldwide since 2010 in real estate and construction. These startups have received around US\$19.4 billion in funding over the period, half of it in 2017. (See Exhibit 2.)

Supportive legal frameworks

Governments, particularly in the Nordic countries and the UK, are increasing their CO2 and energy efficiency regulations and raising their targets. Digitalization provides a great opportunity to reduce the environmental impact of construction projects. There will also be heightened requirements on data usage and cyber security in buildings and infrastructures

going forward that will need to be carefully analyzed (General Data Protection Regulation). Importantly, labels and groups are also more and more launched to help the market move in one common direction and support innovation.

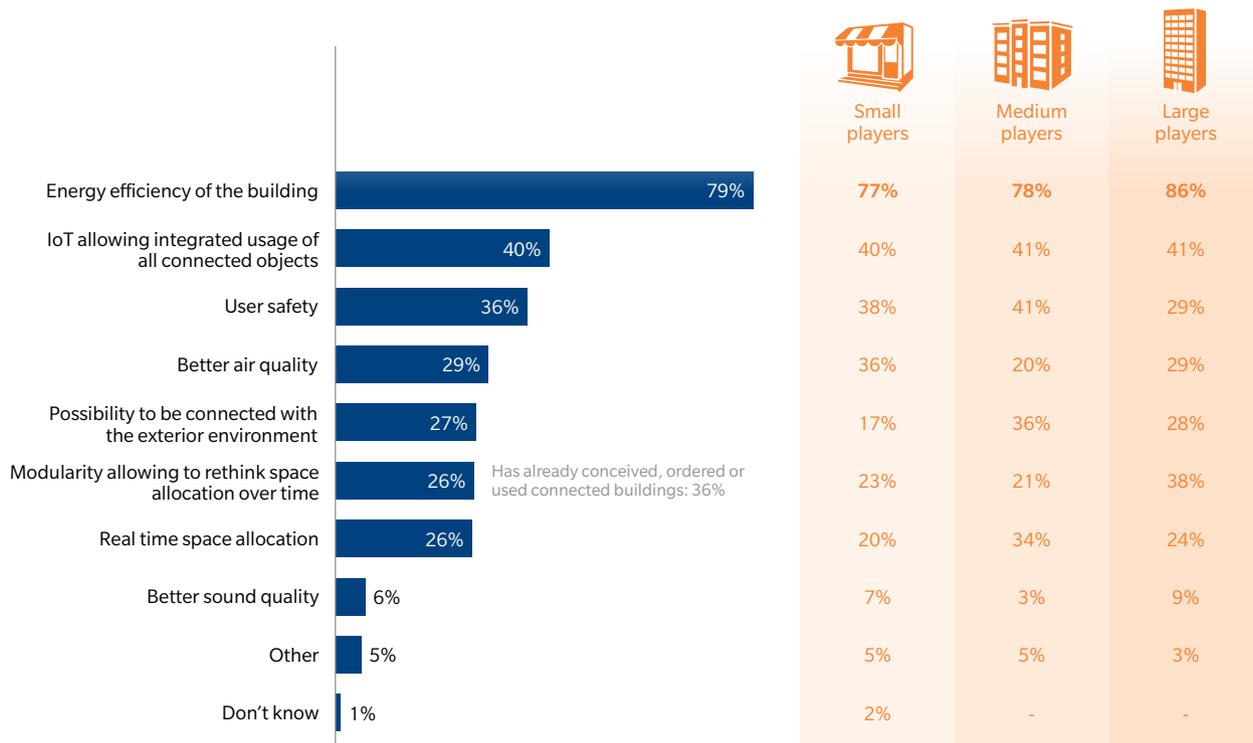
Launch of large infrastructure projects

Market needs are tremendous in terms of new infrastructure networks between cities (such as the Grand Paris Express with 200km of new automated metro lines in France, the High Speed 2 in the UK or the Rastatt tunnel in Germany) as well as in terms of upgrading partly old existing structures.

All players in the industry, whether they are promoters, engineering companies, builders, suppliers of equipment, materials, or distributors **will be impacted by digital pressures**. Each one will experience this differently, of course, but there is no doubt that significant change is coming. The outlined trends put pressure on incumbents (both equipment and traditional construction and service players) by producing a more complex and dynamic competitive landscape and the progressive disruption of traditional channels in the battle for customer access and control.

Exhibit 1: Priority needs during the conception phase

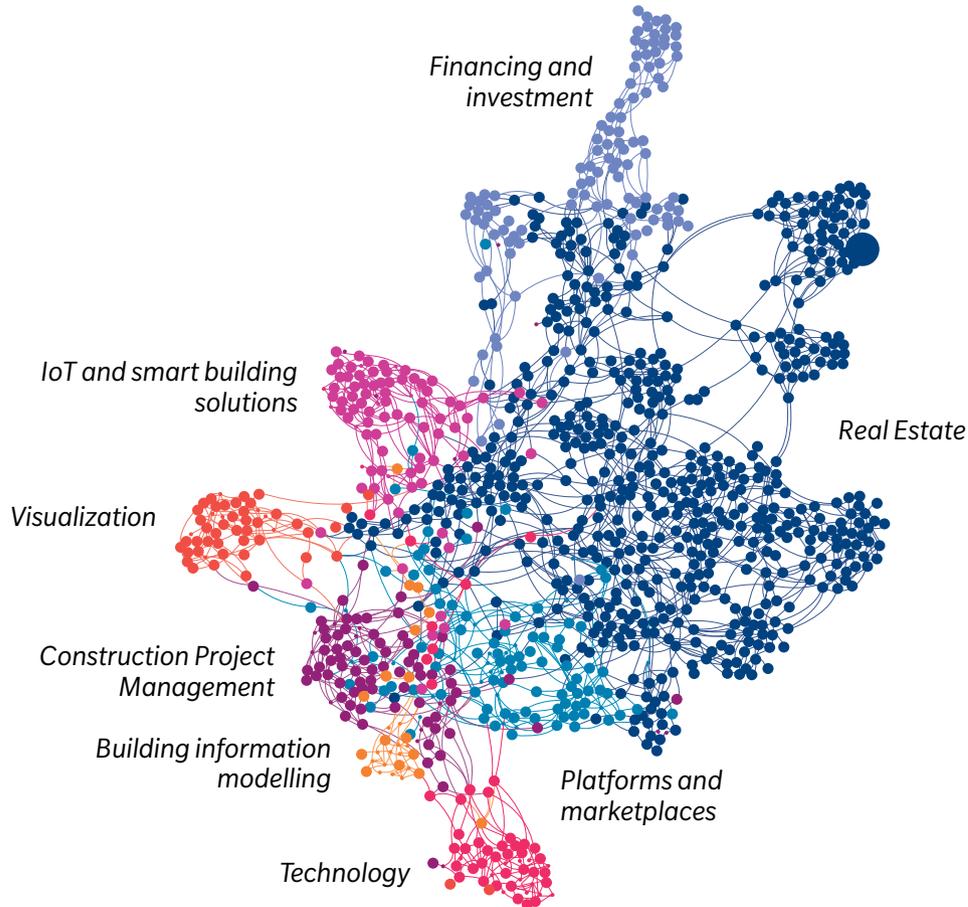
DURING THE CONCEPTION PHASE OF A CONNECTED BUILDING, WHAT ARE THE SOLUTIONS THAT SHOULD BE DEVELOPED FIRST ?



Note: Small players refers to French TPE, Medium players to French PME, Large players to French ETI & Grandes Entreprises
 Source: Oliver Wyman & Le Moniteur study, June 2017

Exhibit 2: Construction startups landscape

STARTUPS CLUSTERED ACCORDING TO SEMANTIC ANALYSIS OF THEIR ACTIVITY
SIZED BY FUNDING RECEIVED. ONE NODE = ONE COMPANY.



| Cluster | # | Funding |
|------------------------------------|--------------------|-----------------|
| ● Real Estate | 611 (52%) | \$13,900MM |
| ● Platforms and marketplaces | 114 (10%) | \$1,500MM |
| ● Financing and investment | 107 (9%) | \$1,600MM |
| ● Construction Project Management | 93 (8%) | \$500MM |
| ● IoT and smart building solutions | 89 (8%) | \$710MM |
| ● Technology | 64 (6%) | \$400MM |
| ● Visualization | 59 (5%) | \$550MM |
| ● Building information modelling | 29 (2%) | \$240MM |
| Sum | 1166 (100%) | \$19,4BN |

Source: Crunchbase, Capital IQ, QUID, Oliver Wyman analysis

TO DEFINE A DIGITAL STRATEGY, IT IS FIRST NECESSARY TO GET THE FULL PICTURE OF DIGITALIZATION'S STAKES AND ASSESS THE CURRENT LEVEL OF MATURITY

Our experience shows that construction players often lack a full picture of the stakes of digitalization for their industry. To define a company vision, they need to answer the following questions with objectivity:

- How are **client expectations** evolving? What are the evolutions that really matter?
- Which **new technologies and offers** come or will come to market in the months and years ahead?
- How is the **player** landscape evolving? What are competitors doing?
- What **start-ups** should be partnered with or invested-in quickly?
- What is the true **current maturity level** regarding digitalization in the company (in terms of strategic vision and KPIs, employees' skills and missing competencies, key processes, technological readiness and tools)? What operational improvement potentials could still be grasped? What client experience enhancements could be launched? How digitalized are the offers in the market compared to competition? How differentiated is the current maturity level between business lines?
- What are the **current roadblocks** for improvement the company is facing? How could the company's digitalization be rendered more "complete" and "solid" while accelerating its pace? How to change the company's culture, making it more agile, more flexible, and ready to face the challenges ahead? Is the ExCom aligned on the vision and the digital roadmap? What should be the role of the corporate to accelerate the sharing of best practices and to scale-up the benefits from local POCs?

Addressing these questions is essential given the current state of the construction industry. **The market is not on "cruising mode" anymore.** Its complexity and hence related threats but also opportunities are booming making it **compulsory to understand an increasing number of variables so as to stay ahead of the game.**

In the same way, **it is essential to always consider in coherence the full picture**, the entire digital ecosystem of the company: Designing and carrying out a digital strategy can't for instance be efficient in the long run if one considers options through a "siloed" and Proof of Concept (POC) lense powered by individually progressing business units only. In the same respect, designing a digital strategy should eventually not be about seeing separately the stakes of building information modeling (BIM), digitalization in operations or digital customer experience for instance.

Digitalization should first be **about taking a step back so as to grasp the full complexity of the stakes, thereby enabling the efficient launch of a real game-changing digital approach**. Of course, this is not always easy, as inertia has to be overcome and maturity levels often vary between business units. Hence, POC starters in one specific area or full strategies in a selected business unit may be good options to begin with, but only if the big picture is not lost during the journey.

CONSIDER BIM AS THE BACKBONE OF THE DIGITAL STRATEGY

Building information modeling (BIM) should be regarded as the backbone of the new way of working triggered and targeted by the digital strategy given that different elements (such as various software, drones, construction engines, building and infrastructure equipment) should ultimately be connected to it.

Overall **BIM – especially 5D integrating planning and budget – is expected to trigger significant improvement potential (direct costs, quality, delays, security, image) along the full construction value chain (design, construction, operations and destruction)**. This potential can be further enhanced if possible connections to the

Exhibit 3: BIM related levers

BUILDING INFORMATION MODELING (BIM) WILL IMPROVE WORKING PROCESSES THROUGHOUT A CONSTRUCTION PROJECT'S LIFE CYCLE

| Design | Construction | Operations |
|--|--|---|
| <ul style="list-style-type: none"> Optimized offer conception (client requirements vs. costs ratio) through informed, visual and multiplied simulations Reduced sales costs through improved product visualization up to possible co-conception Reduced rework through clash detection Improved project productivity through more efficient project planning and steering BIM as an enabler for industrialization of processes and parts | <ul style="list-style-type: none"> Improved field productivity through coordinated scheduling (logistics, maintenance) Reduced sourcing costs through optimized specifications, quantities, and facilitated negotiations Reduced security incidents (workplace injuries) through behavior monitoring and facilitated risk awareness Eased construction progress tracking through field solutions | <ul style="list-style-type: none"> Improved handover management through documented BIM model Optimized maintenance scheduling (inspections, repairs) through full project transparency Facilitated building energy management (and others such as light and air quality) through BIM empowered dashboarding Reduced warranty costs induced through less field failures Optimized management of decommissioning through transparent materials and quantities documentation |

Source: Workshop Oliver Wyman and Autodesk

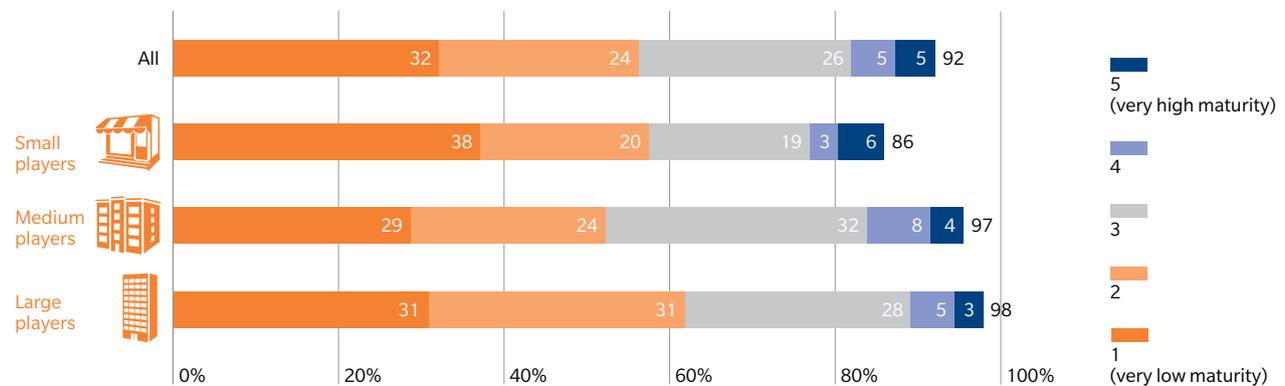
BIM are used and hence if **BIM acts as a real central coordination methodology and cockpit** of a given project (and not only as a “siloeed” software). We estimate that in this case around **15 percent to 25 percent total cost savings** are achievable. (See Exhibit 3.) Recent evolutions also connect BIM and Geographic Information Systems (GIS) triggering additional opportunities. Important to notice, BIM also serves as an enabler for the industrialization of processes and parts.

Of course, while it always remains a priority, **the focus on BIM will vary from one construction player to another depending on their position on the value chain**. For instance, promoters, contractors, equipment manufacturers or facility management operators will consider BIM differently. Similarly even among contractors, building and infrastructure players, different BIM approaches will be used. This will likely trigger a displacement in value capture along the chain. **General contractors** may benefit more from higher-efficiency engineering and better managed project lead times as well as reduced waste; building **material suppliers** may see some of their volumes diminish. This may push upward integration and further concentration of building material suppliers to capture value.

Important to notice: Other industries (such as automotive, shipyards, aeronautics) went through a similar transformation already a long time ago with the rise of CAD/CAM, leading to massive changes in these industries (module and system buy, co-engineering, full outsourcing of functions, emergence of tech centered giants Tier 1 OES, seconded by smaller Tier 2 players...). So even if the situation today will obviously be different, and markets differ, construction players should take benefits from those past experiences in their own transformation. This is all the more true than a recent study we conducted shows that BIM maturity levels in construction are still quite low, beneath their true potential. (See Exhibit 4.)

Exhibit 4: Present BIM maturity level

ON A 1 TO 5 SCALE, HOW DO YOU ASSESS YOUR BIM IN CONCEPTION PHASE MATURITY LEVEL ?



Note: Small players refers to French TPE, Medium players to French PME, Large players to French ETI & Grandes Entreprises
 Source: Oliver Wyman & Le Moniteur study, June 2017

WORK ON DIGITAL OPERATIONAL EFFICIENCY LEVERS

Digital opportunities in operations are numerous. For industrial players they mainly fall under the “Industry 4.0” framework, whereas for distributors they are related to “omni-channel operations”. For contractors we have identified three specific “smart operations” lever categories: (See Exhibit 5.)

Interactive work processes

Virtual, augmented and mixed realities as well as dematerialization, in-situ documentation, connected schedules and immediate planning adjustments, vision of historical changes. Process efficiency has the potential to drastically increase through more efficient, transparent and rapid collaboration.

Exhibit 5: Digital operations efficiency levers

DIGITALIZATION OFFERS NUMEROUS OPPORTUNITIES TO INCREASE OPERATIONAL EFFICIENCY (DIRECT COSTS, DELAYS, SECURITY, AND ENVIRONMENTAL IMPACT)

| Interactive Work processes | | Connected machines, equipment, and workers | | | | | Industrialized models |
|---|---|---|---|---|--|--|--|
|  |  |  |  |  |  |  |  |
| Use of visualization and simulation | Dematerialized and reactive workflows | Accelerated data collection and analysis | Connected workforce and tools | Smart energy management | Machine performance optimization | Automation | Industrialization of processes and parts |
| <ul style="list-style-type: none"> Virtual, augmented, and mixed reality | <ul style="list-style-type: none"> Dematerialized and in-situ documentation management/updates Instant connected schedule coordination of work, inventory and transport Network of sub-contractors and support to bidding, selecting and contracting | <ul style="list-style-type: none"> Surveying, scanning, and mapping Progress and incident monitoring Performance, inventory, and incident monitoring | <ul style="list-style-type: none"> Connected workers, exoskeletons for support Tools inventory management and tracking/localization | <ul style="list-style-type: none"> Energy consumption optimization Rapid failure correction | <ul style="list-style-type: none"> Localization, fuel, idle time, safety tracking | <ul style="list-style-type: none"> Semi-automated to automated vehicles and processes | <ul style="list-style-type: none"> Production on adjacent sites/prefabrication/modules Additive printing of specific parts |

Source: Oliver Wyman analysis

Connected machines, equipment and workers

All machines and equipment (and even the workers on construction sites) have the potential to ultimately be connected, triggering improvements on dimensions such as maintenance, energy consumption, health and safety incidents, delays or quality. Robotics related innovations are also being tested and increasingly applied to automatize the execution of repetitive tasks and support workers.

Industrialization of processes and parts

Construction tends to industrialize through pre-fabrication, modular production or 3D printing for instance which is without doubt a big opportunity to increase the productivity in the sector.

Digital construction processes have nothing in common with the old fashioned “pen and paper methods” of yesterday. The expected impacts on direct costs, delays but also safety, image, work satisfaction and environmental protection are numerous. **Key here is to select levers very carefully** differentiating business units and projects. Not all “great digital ideas” that appear on the market will eventually carry real savings. More importantly, as already outlined above, **operational efficiency levers should not be considered by the material function alone for instance, or similarly project by project with isolated “POCs”: it is a matter of defining a real strategy, beyond specifics, that will generate synergies in coordination with BIM.**

DON'T FORGET TOP-LINE OPPORTUNITIES

When discussing with our clients, digital is often considered as being about operations first. This way of thinking can easily be understood as construction companies are traditionally often driven and ruled by their construction sites. However, the time of contractors without marketing functions ruled by “site production” is long past. **Similar to other businesses, they now need to rethink the customer experience and find innovative offerings.** (See Exhibit 6.) Other players along the value chain, even if they are already more advanced on the topic (such as promoters or equipment manufacturers for instance), will also have to reinforce this new way of thinking. While we are not in the consumer-packaged goods market yet, **client centricity is definitely a disruptive and long lasting market trend in the industry.**

We identified two main levers that should be reflected on:

Improved customer experience

Clients are increasingly becoming part of their own project, through enhanced visualization and possible participation in conception for instance. Moreover, facilitating their often very heavy administrative burden and really caring about their satisfaction at every stage of their journey becomes a priority. Platformization of the promoter business is also part of this change given that it ultimately aims at reducing costs and facilitating the client’s experience.

New offers

Overall, it’s now “less about the product and more about the service”. Players of the industry need to become flexible, distance themselves from the old fashioned and not always transparent “brick and mortar” way of working. Now the clients want more a “product + services package”, performance tracking and guarantees on various indicators (energy related as #1 but also many others related to health, environment and security for instance), support in financing, in legal tasks. All options are open for creativity. More generally speaking, clients want their needs to be prioritized. **It’s not about pushing a project to market anymore but it’s about partnering with the client and integrating his constantly evolving expectations.**

Going forward, **“top-line” client needs have to take their rightful place as key inputs for the digital strategy.** This is a necessary change of paradigm given that the competition will also, now more than ever, take place in this area.

Exhibit 6: “Top-line” opportunities

BEYOND OPERATIONS, DIGITALIZATION IN THE CONSTRUCTION INDUSTRY TRIGGERS OPPORTUNITIES TO RAISE SALES AND ENHANCE CUSTOMER SATISFACTION

| Improved customer experience | | | | | New offers | | | |
|--|--|---|--|--|--|--|---|--|
|  |  |  |  |  |  |  |  |  |
| New channels | Enhanced visualization, tours & visits | 3D simulation tool | Simplified admin. workload | Customer satisfaction tracking & improvement | Enhanced products with new possibilities | New services and partnership models | New financing options | Multiple performance tracking |
| <ul style="list-style-type: none"> Digital contacts, internet platforms | <ul style="list-style-type: none"> 2D to 3D plans transformation Virtual reality | <ul style="list-style-type: none"> 3D simulation tools | <ul style="list-style-type: none"> Dematerialized standardized and simplified documentation | <ul style="list-style-type: none"> Client centricity: new ways of interacting with clients, evolving KPIs | <ul style="list-style-type: none"> Smart buildings, smart infrastructures, and smart cities | <ul style="list-style-type: none"> From builder or promoter to partner (individualization, flexibility) | <ul style="list-style-type: none"> Tailored and innovative financing options | <ul style="list-style-type: none"> Multi-dimensional transparent performance ROI Value in data |

Source: Oliver Wyman analysis

REINVENTING WAYS OF WORKING

All opportunities described above will most likely remain pure theory if the ways of working do not evolve. **Digitalization is not only about technologies, it is also about organization, processes and people.** But even that is not enough, as **shifting the company's culture is eventually what's really at stake.** (See Exhibit 7.) In other words, digitalizing a company is about changing its behaviors and **providing a renewed purpose and identity** aligned with these behaviors for the long run.

Based on our experience, we **identified different key success factors** to enable a long lasting digital change from a ways of working point of view:

Make it a top management supported project

The journey ahead is being driven by cultural shifts that reach far beyond isolated tests. Hence, it has to be directly led by the leadership team to demonstrate its importance, avoid roadblocks and ensure that the means for success are provided. Importantly, the leadership team also sometimes has to evolve in terms of mindset to become fully supportive of the change.

Provide vision and explain the journey

Given the stakes, a company's digital initiative should be launched prominently and with clear communication. In our experience, projects where the company's ExCom planned a kick-off event showing their ambitions in detail are the most successful in the long run as this generates an "alliance" between leadership and operational professionals evidencing that they all are "in the same boat". Besides, the company needs to take advantage of that event, to accelerate its pace and align with the rhythm of the targeted digital change.

Create a central digital function

The centralized vision has to be carried by a new function that holds the operational responsibility of the project and symbolizes the change. In this respect, we are often asked by our clients whether the IT department should be in command of the change. While IT is of course a core part of it, we support the implementation of a new department that should handle BIM, digital operations, digital top-line opportunities but also organizational and cultural shifts. Digitalization is not only a question of systems, it's mainly and above all a question of overall transformation with shared and transparent direction, capabilities, data and resources.

Provide the resources and structure for the project

Once underway, the digital project demands a strong framework with working groups and regular reporting to track progress and ensure efficiency. Roadblocks will need to be addressed without delay. More importantly, while the framework should play its role, flexibility should also be guaranteed all the way through. In fact, resistance to change will be encountered and is to be managed with a subtle touch, open to feedback and needs coming from teams. In the same respect, regular communication is fundamental to avoid any black-box effect that might undermine the evolution.

Put people in the heart of the digitalization

Beyond processes, transparency and feedback loops, nurturing the creativity of operational managers will be essential. Digitalization has the particularity of confronting the organization with various options that should be considered with an open mind. Incentivizing managers for their involvement in the company effort and rewarding early adopters of the new mindset is key for success. Besides, the training effort will be a priority dimension for construction industry players as they need to rapidly shift processes and sensitivities of construction site managers for instance. This might constitute a risk in the short term (as it changes long term habits) but is also a great opportunity to provide innovative career paths and evolutions and grasp the strengths of both the old and of the new ways of working.

Broaden the network

A digital world is by definition open, with diminishing boundaries and raising complexity. To succeed in terms of change, construction industry players need to increasingly “think out of the box”, generating more partnerships or launching investments. Value chain positions are no longer constraining which implies a change of mindset in a traditionally fragmented sector. Appropriate alliances will be one essential trigger for a prosperous evolution.

Care about data

Digitalization will generate significant amounts of information. This information will arrive more and more immediately and cover a large variety of topics. Of course this represents a huge opportunity to generate new value but requires adapted processes and a new specific focus. Without a change in mindset and a structured approach one can easily and very quickly loose its way or even drown under the amount of information generated.

Exhibit 7: Necessary evolutions of the operating model

SIGNIFICANT SHIFTS ON THE OPERATING MODEL ARE REQUIRED TO MAKE THE DIGITAL TRANSFORMATION A LONG-LASTING SUCCESS

|  Organization |  Processes |  People |
|--|--|---|
| <ul style="list-style-type: none"> • From silos to transversal CDO impact • Integration of external partners (new boundaries) | <ul style="list-style-type: none"> • Customers placed at the heart of every process | <ul style="list-style-type: none"> • Enhanced/Adapted competencies (new skills, smart training, efficient management of knowledge) |
| <ul style="list-style-type: none"> • Enhanced focus on technology and innovation • Prioritization of data (to optimize and monetize) | <ul style="list-style-type: none"> • Enhanced support of tools and clean data baselines | <ul style="list-style-type: none"> • New career tracks and incentives (for new functions in the company, leadership of tomorrow preparation) |
| <ul style="list-style-type: none"> • Increased speed of partnerships and investments • More risk taking | <ul style="list-style-type: none"> • Tracking of new metrics and reporting | <ul style="list-style-type: none"> • Regular and transparent communication on vision and advancement • New surroundings that boost creativity |

Source: Oliver Wyman analysis

CONCLUSION

Digitalization in the construction world is in its infancy. While innovation is booming it still remains scattered and not really organized. Nonetheless, **digital in construction will eventually generate usages and breakthroughs that we simply cannot conceive yet.**

Our conviction is that the time is right for the implementation of a real digital strategy in the construction sector. The possibilities of BIM, the rapid growth of various start-ups, the increasingly demanding client expectations make it compulsory to **shift from a siloed POC mode to a real overall strategy**, with a clear mid/long term disruptive vision communicated to the company and a three to five years roadmap. In this respect it all comes down to defining a balanced transformation for construction industry players: on the one hand, it must be framed, planned, efficiently carried by company leadership; on the other, it must allow for creativity, new ideas, a quicker market pace, flexibility, and open partnerships. To say it differently: **a broadened vision on a paved road.**

It is our opinion that launching a new strategy is not really an option, it has now become unavoidable. Digitalization is currently in a process of reinventing the construction industry, triggering an overall value migration from the central construction part of the value chain up to the engineering and design function and down to facility management and operations' services. Numerous data will be generated throughout the construction process and will hold tremendous value that needs to be captured. In addition, cost baselines are quickly evolving making competition even more intense in an environment with traditionally low margins. **Taking quickly position, aligned with the accelerating market pace, is essential to take advantage of the opportunities and avoid future setbacks in the long run.**

ABOUT OLIVER WYMAN

Oliver Wyman is a global leader in management consulting that combines deep industry knowledge with specialized expertise in strategy, operations, risk management, and organization transformation.

www.oliverwyman.com

AUTHORS AND CONTACTS FRANCE

DAVID KAUFMANN
Partner
david.kaufmann@oliverwyman.com

XAVIER RUAUX
Partner
xavier.ruaux@oliverwyman.com

MICHEL JACOB
Partner
michel.jacob@oliverwyman.com

CONTACTS

GERMANY

ROMED KELP
Partner
romed.kelp@oliverwyman.com

WOLFGANG WEGER
Partner
wolfgang.weger@oliverwyman.com

NICO HARTMANN
Partner
nico.hartmann@oliverwyman.com

SWITZERLAND

GREGORY KOCHERSPERGER
Partner
gregory.kochersperger@oliverwyman.com

NORDICS
BO KAUNITZ
Partner
bo.kaunitz@oliverwyman.com

SPAIN

ALEJANDRO GAFFNER
Partner
alejandro.gaffner@oliverwyman.com

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