

REMOVING BARRIERS IN THE VALUE CHAIN

Opportunities and challenges for improvement
in the construction supply chain

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REMOVING BARRIERS

The construction supply chain can greatly benefit from the application of supply chain management

As the oil economies of the Gulf continue their rapid transition from growth driven by state-backed capital projects into more competitive, private sector-led markets, the focus increasingly is on finding ways to be more productive and reducing waste.

For the construction industry in the UAE, one of the biggest opportunities for driving efficiency is to streamline the way it buys the products and services it needs to deliver projects.

The construction industry in the UAE is highly fragmented and prone to overruns and disputes. Its supply chain involves complex networks of people, companies, processes and products and is riddled with the potential for costly clashes and delays. These risks are exacerbated by the traditional model for buying services, which is centred on lowest-price wins competitions for works contracts.

The traditional model of competitive tendering for contracts means that almost every product or service is being purchased as if for the first time, even when the companies and services are well established and repeated again and again across countless projects.

There is immense opportunity for the construction industry to streamline these processes by adopting some of the practices used in other industries such as manufacturing, oil and gas and defense. These sectors are characterised by a smaller pool of project spenders, who tend to procure services on a repeat basis, and who prefer to use formal models of supply chain management to ensure they get more value for every dollar that they spend.

Done properly, supply chain management encourages greater collaboration between companies by removing the barriers of direct competition. This can enable higher levels of quality, time savings and reduce conflict through more honest pricing. Supply chain management can also allow project owners to introduce a broader range of objectives into its project procurement processes. These might be used to promote environmental sustainability criteria, better working conditions or local sourcing.

One of the challenges for the effective roll out of supply chain management across the UAE construction industry is the fragmentation of a market that features thousands of one-off clients. There is a role for government to play to provide a national construction supply chain of qualified contractors, consultants and suppliers.

Further efficiencies can be introduced into the construction supply chain through more adventurous use of innovative technologies such as building information modelling (BIM), 3D printing and cloud-based data management systems. These new digital data processes open up the possibility of virtual warehousing, local manufacturing and genuine full project lifecycle management.

Removing Barriers takes a detailed look at the opportunities and challenges for improvement in the construction supply chain in the UAE. It is the ninth report produced by the MEED Mashreq Construction Partnership, and it is our hope that this report, together with its predecessors can help stimulate new ideas and practices that will help deliver a better construction industry in the UAE.



EXECUTIVE SUMMARY

- A construction supply chain is a complex network with numerous relationships and materials, products/services, logistics and information, and cash flows. Increasing fragmentation in the industry adds to this challenge by adding more specialised suppliers and contractors in the mix
- The traditional construction project delivery model has generated many problems, as project parties tend to work in a step-by-step manner within silos. Factors such as lack of coordination between design and construction deepens the gap between the contractors and design, resulting in challenges further down the supply chain
- Supply chain management (SCM) can be a solution to construction's supply chain woes, but requires a change in industry mindset. SCM is driven by a collaborative approach that focuses on higher customer satisfaction levels, a target often not considered pivotal by construction stakeholders
- Today's construction supply chains are still largely analogue, governed with paper-based processes. Automation is limited and the required capital investment in technologies hinders many project owners and contractors from pursuing digital solutions
- Technologies such as building information modelling (BIM) can offer an integrated view of the entire supply chain and help deliver insight-driven projects. It can also reduce the wastes generated during the construction process and improve the entire lifecycle. The process can be further enhanced by combining BIM with solutions such as additive manufacturing, asset management and artificial intelligence
- Contractors should subject their supply chain to tougher sustainability criteria in order to drive positive change. Sustainability should be considered right from the design and scoping stage as its benefits extend well beyond the construction phase

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The construction industry needs to work together to jointly realise the benefits of a stronger supply chain

UNDERSTANDING THE CHAIN

The construction supply chain can benefit from establishing long-term relationships and a more collaborative model focusing on client satisfaction

Poor productivity, budget and time overruns, and conflicts and disputes have contributed to the failures of the construction industry for a long time.

These problems are only magnified by the strained relationships between the various project parties. There is a lack of coordination and collaboration between the design team, main contractors, subcontractors and suppliers involved during the lifecycle of the project.

This adversarial behaviour of the players results in one-time, project-focused relationships, causing problems throughout the supply chain.

Challenges

A typical supply chain in the UAE construction sector involves a main contractor, whose downstream supply chain is primarily made up of suppliers and subcontractors.

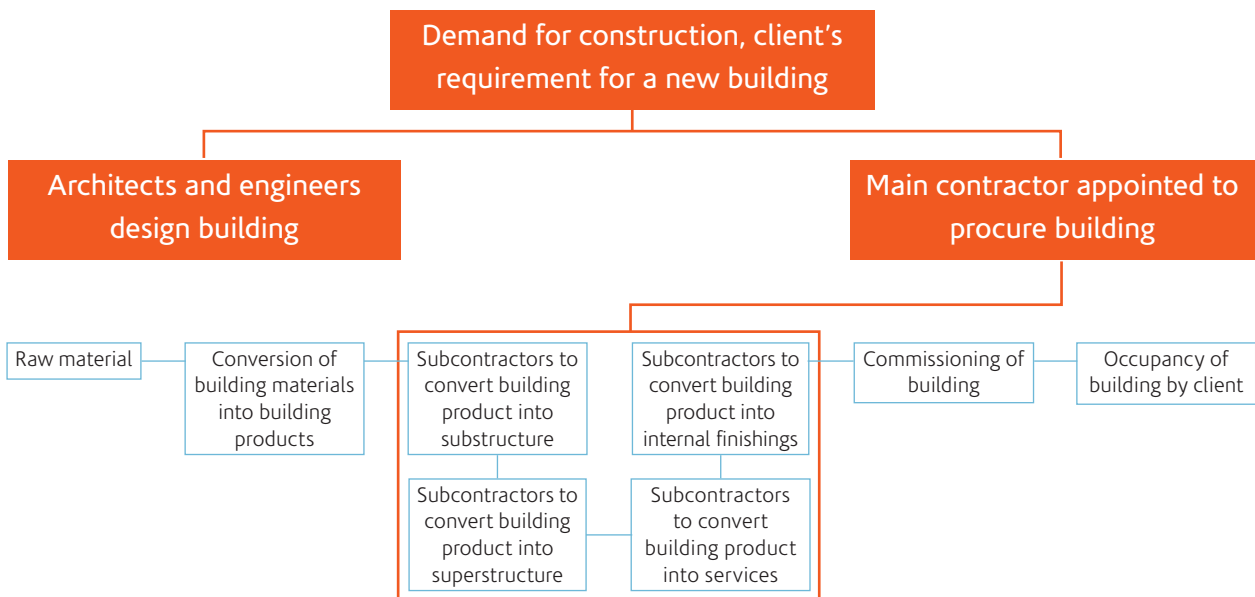
Suppliers generally supply materials only, while subcontractors will provide a supply and installation services of various composite trades.

Consultants are often appointed directly to the client ie, a traditional procurement route, with contractors being appointed separately by the client for the construction works. The contractors may then engage separate consultants to complete the design during construction.

"There are occasions on a number of projects [where] we are appointed by the client's architect," says May Winfield, commercial associate director at BuroHappold.

Such a supply chain often involves rigid bureaucratic processes and a lack of flexibility in negotiation of contract terms which restrict and impact all levels of the supply chain. These issues may be driven by lengthy or onerous client requirements and processes, and a regular desire of parties to pass liability/risk down the supply chain.

A typical construction supply chain



Source: Paper titled "Construction Supply Chain Partnerships: Skills, Knowledge and Attitudinal Requirements" from the European Journal of Purchasing & Supply Management

“The material supply chain almost exclusively relies on locally established resellers/middlemen to route goods and materials from the manufacturer into the UAE,” says Andrew Watson, project director Middle East at Faithful+Gould, a member of the SNC-Lavalin Group.

But this can be a challenge as the middlemen provide little or no after-sales support and service.

The fragmented and bespoke nature of construction projects also makes them susceptible to miscommunication. There is a plethora of project players on any given project, and these teams tend to be project-based. This means that by the time lessons are learned from a project, the cycle has ended and the teams disband for the next assignment.

This affects the supply chain, where no long-term relationships are formed between the client and contractor, subcontractors and suppliers.

“Suppliers [are] no longer prepared to take the risk of non-payment for goods provided,” says Barry Lewis, managing director at Alec. “They have tightened up their payment terms and will generally insist on letters of credit, which are to be paid on provision of the bill of lading. The challenge with this is that not all contractors have sufficient credit lines to support this additional financial burden.”

Subcontractors are facing similar financial issues as a result of under-certification/late/non-payment for works done and failure by clients and consultants alike to deal with variations in a timely manner. The financial burden that now has to be borne as a result of the payment failures eventually cripples the subcontractors and they are unable to fulfil their delivery obligations.

More often than not, the failure of the subcontractors or suppliers is a consequence of someone else’s failure and not their own.

Solutions

Supply chain management (SCM) can work as an effective solution to the industry’s problems. SCM is the management of the flow of goods and services and includes all processes that transform raw materials into final products. It helps streamline a business to make it as efficient and economical as possible, encouraging collaborative working.

If applied to construction, SCM could improve collaboration between the construction contractors, material suppliers, service crews and other involved parties. The stakeholders can form long-term relationships with a mutual objective to deliver quality projects. This would create higher client satisfaction levels and an improved reputation for the industry.

However, applying SCM across the construction sector will not be an easy task and requires a significant change in mindset towards quality-led work. This will include training construction professionals in SCM practices and educating them on the benefits of SCM.

It is also important to establish a clear hierarchy within the supply chain. This defines the levels of authority within the project – for instance, first tier suppliers such as external design consultants who are directly answerable to the client. It also helps sub-contractors and suppliers to recognise their point of contact, allowing the team to work in sync.

Winfield regards the greater use of long-term/framework agreements and early involvement agreements as a way to resolve the fragmentation challenge.

“Greater use of project managers could encourage clients to procure consultants and contractors in a more holistic fashion,” she says, “—considering the whole project life cycle and the various interactions of the supply chain members.”

There is also a need for improved understanding of and trust in the contract documentation. Contracts and related documents should be treated as more than just a transactional paper and pixels; they are assets that hold value, opportunity and risk. These contracts should be geared towards balanced risk allocation between the parties.

In addition, tools such as BIM, data models, open book processes, regular meetings to discuss issues before they escalate, tiered dispute resolution processes (or resolution tools like expert determination and Dispute Resolution Boards) to avoid escalation of disputes can further help secure the supply chain.

Watson remarks that methods to allow more business ownership by overseas manufacturers to represent themselves will help to ensure that after sales service is also improved.

“[Furthermore] incentives for manufacturers to establish their own manufacturing facilities in-country will greatly help with lead times and accessibility to material,” he says.

“Greater use of project managers could encourage clients to procure consultants and contractors in a more holistic fashion”



Changes to the construction industry through added technology will also significantly change the way the supply chain operates. Digital technologies offer improved accountability and auditability, leading to greater trust by parties in the data they receive thereby improving efficiency, reducing time and costs, and improving relationships between parties.

Despite the drive for innovation in the UAE, particularly in the emirate of Dubai, the construction sector is still largely driven by paper-based processes when it comes to procurement and management.

Manual processes such as managing invoices and purchasing orders are extremely labour intensive, time-consuming and prone to errors.

This is an area where digital technologies can reduce errors and improve productivity and efficiency. Project managers need to be enabled with tools that can track every project, various aspects of the budget, purchase order and variations in real time. This would formalise and automate the invoice and PO processes, and most importantly remove ambiguity about what was agreed, both in terms of goods and services and also prices.

“BIM and other tools can be very useful for material quantification and ordering,” says Watson, F+G. “Also, from a facilities management point of view, digitisation can add value if the project is established with key principles from the start.

“Digital dashboards are widely used [on our projects]

to steer clients through the challenges of large project or programme material consumption and to highlight the risks and opportunities that exist when strategic supply chain engagement is on the clients’ agenda.”

Project owners may be hesitant about deploying digital solutions due to the capital expenditure costs, but the savings in operational expenditure will balance this investment in the long-term. Solutions such as cloud-based management and BIM offer an integrated and single point of view of the supply chain, and will enhance the decision-making process and optimise upkeep.

Care for the impact

“Clients are becoming more and more aware of the importance of incorporating sustainability practices into their projects early on, from planning to execution, and operations and maintenance,” says Watson. “We can see today that many governments across the GCC are also putting sustainability high on their agenda.”

Engaging the supply chain is especially challenging in the construction industry as cost continues to be the driver behind design and specification decisions.

Hence, creating key guidelines and enforcing mandatory sustainable design and restrictions on non-renewables is vital to incorporate sustainability across the supply chain.

“At Faithful+Gould, we increasingly think about our performance along the three dimensions or triple bottom line of sustainability—economic, social and environmental,” explains Watson. “Our goal is to embed this perspective in our approach to everything we do, and we particularly look at how we can reduce the operational costs and, therefore, the environmental impact once the asset is operational.”

Sustainable practices need to be considered right from the design and scoping stage, including seeking early involvement from specialist contractors and suppliers. Winfield recommends that it should build into the request for proposal/pre-qualification documentation and award criteria.

“Clearly specify [it] in the contract and measure performance against this – linking KPIs and deliverables criteria,” she says.

A change in attitude towards environmental matters will ultimately need to be driven and supported by the client, with obligations flowed down to the supply chain through their appointments.

“By legislating the requirements and through enforcement one can create the required behaviours,” says Lewis. “The supply chain will adapt to change in order to continue trading, failing which they will not have anything to trade.”

LEARNING NEW LESSONS

Lean production, collaboration and adopting digital solutions are just some of the practices construction can learn from its peers

Despite continued calls for change, inefficiencies in construction industry supply chains continue to adversely impact the effective delivery of projects.

A fragmented supply chain, traditional procurement practices focused on obtaining the lowest price possible, and solutions that inadequately consider supply dynamics and complexity continue to cause issues. Late or incorrect material delivery, demand variability (causing either a lack of materials or large inventories) and waste in processing time or materials remain common.

While initiatives are underway in some areas, the construction industry can benefit from looking to other industries for examples of good practice and opportunities to improve.

Becoming 'lean-er'

One of the key principles of lean production, originating from the automotive manufacturing industry, emphasises the importance of working collaboratively with suppliers to eliminate waste in the production process.

Suppliers operating in a lean environment are encouraged to come together to share ideas to improve processes, reduce waste and cut costs so that all parties improve profitability. This is done by creating long-term partnering arrangements in the supply chain, avoiding lowest price procurement and not castigating suppliers for errors made.

UK government's Highways England provide a good

example of where 'lean construction' is beginning to be realised within client organisations. Highways England engage with the supply chain to build capability for lean projects, with a particular focus of visual management and collaborative planning.

Highways England's lean maturity assessment measures progress made by supplier organisations and provides guidance on how to develop further.

Lean tools are also beginning to be used across other sectors in the industry with just-in-time delivery of materials and collaborative planning solutions (such as last planner) being used to integrate complex and interdisciplinary supply chains on railway projects.

Collaboration across the supply chain

The oil and gas industry is committed to place collaboration at the centre of its supply chain management approach in order to overcome the challenge of increased costs deriving from complex and conflicting requirements and non-standard solutions.

The industry is seeking to reward efficiency and collaboration across the supply chain through earlier and better use of supplier expertise during the project lifecycle. Financial drivers for operators, contractors and suppliers are also aligned to incentivise collaboration and produce cost-effective and value-driven designs.

Through this collaborative approach, the oil and gas sector is seeking to accelerate and increase the effect of digitalisation and standardisation of products to drive win-win scenarios for all industry players.

By comparison, while there are examples of early contractor involvement across the construction industry, it is largely undertaken without the necessary commercial environment and operating models that align supply chain objectives and encourage collaboration between parties.

The emergence of project delivery models such as Integrated Project Delivery (IPD) in the US and Project 13 in the UK provide frameworks to embed collaboration in the construction industry. IPD's approach in particular emphasises the alignment of commercial incentives and an operating model comprising capabilities in digital and lean construction tools, such as digital twins and the last planner system.

"One of the key principles of lean production, originating from the automotive manufacturing industry, emphasises the importance of working collaboratively with suppliers to eliminate waste in the production process"

Industry lessons

These innovative delivery approaches represent a significant shift away from the current status quo of engineering, procurement and construction contracts which often results in inequitable allocation of financial and non-financial risk.

Digitising control of delivery

Adopting digital solutions is a key enabler for more collaborative supply chains, and the aerospace and defense industry has effectively turned to digitalisation to improve efficiency in its supply chains.

Through the utilisation of common data platforms and cloud-based supply chain management applications, all tiers of aerospace and defense suppliers are able to operate efficiently which results in optimised procurement processes. The industry is also embracing connected devices (Internet of Things) and harnessing performance data to predict the maintenance needs of critical assets.

Embracing digital technology will likely bring significant benefits for supply chain management in the construction industry.

One example is the use of digital twins for automated material logistics planning and management. By using digital twins during the construction phase, geometric and material information can be extracted from the digital model (BIM) of the asset and used to facilitate just-in-time deliveries from suppliers, in line with the construction schedule.

Digital twins can also be shared with supply chain members to communicate site constraints in regard to material delivery and storage.

An obstacle to such practices becoming widespread has been that only the largest construction businesses have been able to afford investment in sophisticated IT systems to improve their business processes. However, the increased availability and affordability of cloud-based solutions appropriate for construction SMEs has the potential to overcome this barrier.

The construction industry can also learn lessons from other industries in areas such as supply chain control and the re-assessment of delivery capabilities. The aerospace industry, for example, is seeking to gain greater control over supply chains with companies, such as Boeing, moving towards vertical integration of their supply chain.

This is being done in order to obtain greater control of critical supply chain processes, reduce operating costs (by capturing supplier margin) and increase their agility to adopt to specification changes and client demand.

The case for vertical integration in construction is perhaps strong, given the propensity for large and complex projects to fail.



However, a far less expensive and lower risk approach is for client and contractor organisations to frequently review their internal capabilities against their procurement and delivery strategy, building and developing additional capabilities where required to obtain greater oversight and control of project delivery and the supply chain.

Supply chain management within the construction industry, especially for the delivery of major projects and programmes, is complex and uncertain and contributes to the industry's under performance.

The construction sector can continue to learn lessons on innovative delivery approaches, digital twins and lean construction techniques to improve processes from other industries, allowing supply chain to naturally become more collaborative.

Further focus on defining, designing and implementing a 'supply system' can also help overcome the challenges of delivering complex, uncertain and quick projects and facilitate the effective flow of material, information and capital across the supply chain.

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IMPROVING RELATIONSHIPS

Effective supply chain management could help build long-term relationships

Supply chain management (SCM) presents good practice for the construction industry. With increasing complexity and specialised requirements in today's construction projects, current norms in the construction industry are detrimental to a project's time and quality requirements. Organisations that have implemented SCM initiatives have done extensive efforts to improve product quality and human resource utilisation as well as to reduce lead-times and product costs.

Not enough attention is paid to the pre-construction phase, despite the fact that problems at the earlier stages mostly cause the delays later in a project.

Practices such as awarding based on the lowest price bids, inconsistent project management, and manpower shortage coupled with a lack of resources' management are increasing the demand for subcontractors and suppliers to deliver the same results within constricted price margins.

Short-term projects, long-term relations

SCM is the control of the flow of goods and services including the movement and storage of raw materials, the

work-in-process inventory, and the logistics of transporting goods from point of origin to point of consumption within a limited time frame.

SCM can resolve many procurement problems in the construction sector by building a long-term relationship between subcontractors and suppliers. This can help eliminate time consumed in price negotiations, agreeing to payment terms and conditions, logistics arrangements, and sharing of standard and repeated technical information and data.

The relationship between subcontractors, suppliers and main contractors could greatly affect the performance of the construction team and its outcomes. Subcontractors provide niche solutions such as steel-structure, façade works or pilling/shoring systems. Subcontracting as a concept has more benefits to supply chain practices than the old traditional manpower recruitments and training.

On the other hand, although using information and communication technologies (ICT) will provide a positive impact on the supply chain implementation, the quality of the relation between the contractor and the subcontractors remains the main factor with the greatest effect of this partnership.

A poor performance caused by a bad relationship between a project's subcontractor and the main contractor impacts the project value when communication links and mutual trust are absent. In a short-term relationship, each party is focused on finding the quickest and easiest way to make profits.

A long-term relationship calls for maintaining and strengthening the relationship and building a collaborative environment. Through open communication, there is a decrease in the issues such as over-ordering, or having components not meeting specs, or facing difficulties in payments.

In the field of construction there is a huge diversity in project types which is a real challenge towards implementing any long-term relationship management solutions such as SCM as many contractors are not specialised in only one type of projects, additionally; the location of the contracting firm and the countries they have projects in, could be an obstacle in dealing with only one supplier.

With a better understanding of the interactions between stakeholders across the project's organisations; SCM will be able to improve the performance in the construction industry.

Fragmented Industry

A large number of parties involved in a single project increase the complexity of communication, the likelihood of technical and design errors, and the distance of knowledge and experience between the design and construc-

Stakeholder relations

tion teams, which would be more noticeable when the involved parties are acting in honesty, integrity or good attitude. The better collaboration between parties, the better outcomes in SCM practice.

SCM can also be beneficial to project owners/clients such as utility companies that regularly commission projects which tend to use similar materials for their construction and maintenance works. They can secure a long-term relationship with the suppliers by modifying the scope of work and adjust the contract clauses to be directly responsible for the procurement instead of the contractor. This eliminates the risk on the contractor's side and minimises it to the employer and the project.

However, having an approved vendor list by the client on certain projects can create problems for SCM for the contractor. The contractor may not have a relationship with the approved vendors, and some funded projects have restrictions on both the supplying manufacturers and the products' country of origin.

Procurement management

The biggest challenge in procurement management is ensuring the timely delivery of goods at the specified quality and price. Other considerations to be made are the methods of shipment, storage of delivered items during and after construction, and payments.

Material supply has a huge impact on the timely delivery of most industrial projects; it affects the coordination of other works and machinery on-site, not to mention the performance of these equipment or materials and interaction with the existing systems.

Industrial projects in the past have been slowed down due to delays in the arrival of certain equipment or material, which hinders the contractor from executing other works. Additionally, systems and equipment being installed for industrial expansion projects are often updated versions compared to the existing systems, which causes problems and technical clashes and ultimately results in time and cost overruns.

For a contractor, a good relationship with their most trusted frequent suppliers would help not just in financial terms but also because over time the two parties develop a higher understanding of each other's policies and procedures, specific installation methods, common technical issues and maintenance practices.

SCM and contract types

There are standard practices besides SCM that can minimise communication and procurement risks; For instance, a contractor can be hired under a design and build agreement, where this type of contract includes a main



contractor responsible for the whole project delivery.

In this contract, there should be a deadline for all the material submittals and approvals for the project; by requiring the contractor to submit all the needed preparations and paperwork within a set timeframe (such as 90 days from the commencement date) will help in discovering all the technical problems, difficulties, contradictions at an early stage of the project.

Though design and build contracts have been effective in resolving disputes, unlike SCM they do not solve the problem of delays caused by an unreliable supply chain. This type of contract can improve the SCM practice under the main contractor responsibility.

From the contractors' perspective, SCM as a concept can be implemented in other aspects beyond long lead items during the project timeframe. This includes an accredited list of sub-contractors, planning, and contractual services, engineering office services, and heavy machinery rentals.

The fragmentation in the construction industry and diversity of projects can hinder the full utilisation of the supply chain within construction projects and across different sizes of companies. But SCM could be a solution to many of the construction sector's challenges. Additionally, it can prove how working collaboratively and building a trusting relationship between stakeholders is necessary for project success.

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EDUCATING THE SUPPLY CHAIN

Supply chain management can provide the construction sector with tools to streamline building processes, but training is required to shift industry mindsets

The principles and practices of supply chain management (SCM) can deliver significant benefits to the construction sector. Companies stand to gain competitive advantage through improved inter-organisational relationships, integrated processes, increased customer focus, value generation and cost reduction.

SCM involves the streamlining of a business's supply-side activities to maximise customer value and gain a competitive advantage in the marketplace. The process requires a holistic approach - participants need to develop the ability to look beyond company boundaries and recognise the interdependence of organisations.

The origins of SCM lie in the manufacturing industries, where the focus is on the flow of goods and services and includes all processes that transform raw materials into final products.

SCM in construction

The supply chain in construction consists of a large number of business processes, from the client's initiation, briefing, conceptual and subsequent design and construction, to maintenance, replacement, and eventual decommission of buildings. It involves multiple stakeholders including the client, architect, consultant, contractor, subcontractor and supplier.

This complex network of organisations and relationships requires a reliable flow of information, materials, services,

products, and funds. The dynamics can be significantly improved by the effective use of SCM, which manages the interfaces between the parties involved in a supply chain.

Sectoral challenges

The construction industry has certain peculiarities, such as the one-of-a-kind nature of many projects, temporary collaboration between multiple organisations, on-site production and regulatory intervention, that prevent it from attaining the same efficient flows as the manufacturing sector.

Additionally, building is a process with strong fragmentation, evidenced by the lack of integration in its supply chain. The prevalence of adversarial relationships within the construction industry, and the focus of many organisations on short-term and price-oriented approaches has led to a lack of trust between suppliers resulting in an unwillingness to integrate their processes.

These problems are exacerbated by a lack of information technology infrastructure, especially for medium and small suppliers that do not have permanent relationships with large construction companies.

Educating the supply chain

The SCM body of knowledge contains a significant number of practices and tools that could facilitate the construction process. These practices include strategic planning approaches related to partnering and forming long-term relationships along with operations, logistics, and procurement management.

However, applying SCM in the construction process requires a huge effort. It entails developing vertical integration in the design and production process and operations to link the process into a chain focusing on maximising opportunities to add value while minimising total cost.

There needs to be a significant shift in the mindset of the participants towards collaboration, teamwork and mutual benefits. Educating construction professionals in SCM practices and their benefits could help to make this change.

The training of construction professionals can be structured to support the decision-making process at different managerial and operational levels throughout the construction phases. A partial listing of such decisions and the



Construction phase	Decisions	Supporting SCM knowledge
Planning and design	<ul style="list-style-type: none"> Identifying construction supply chain (CSC) configuration Developing tools and methods for CSC planning and management Identifying CSC risks Building construction information technology Construction and logistics planning (including transportation, site layout and material handling) 	Operation strategy Supply chain strategy Product and service design Risk management Logistics planning
Procurement	<ul style="list-style-type: none"> Building partnerships Supplier selection Production planning Purchasing materials Material storage 	Strategic sourcing Warehousing Distribution Planning and control
Construction and delivery	<ul style="list-style-type: none"> Construction execution, site layout, material handling Construction logistics Controlling on-site information flow 	Scheduling Logistics Lean management

Table 1: Structuring the supply chain management training of construction professionals

supporting SCM body of knowledge is listed in table 1.

SCM education is considered a mature field in the production and manufacturing industry. But there is a need to adapt this training to meet the specific needs of the construction industry. These requirements include:

- Top executives and senior management training programs for strategic design and integration of the construction supply chain, including supply chain performance measures and risk assessment
- Middle and operational management programs that focus on intermediate planning of issues such as sourcing, procurement, distribution and logistics
- Site managers and supervisors training programs for the short-term planning of issues including labour scheduling, logistic execution and material handling

There are many executive and professional training courses provided by professional societies focusing on SCM within the manufacturing industry. However, there is a scarcity of mature and well-established professional training programs for the construction supply chain. training programs, which could be developed through

collaboration with some of the prominent SCM societies or academia. Current academic programs for construction professionals do not have a curriculum that meets the emerging needs of the industry with respect to SCM practices.

Universities should be urged to revise their curricula to include new concepts and knowledge to prepare young engineers and construction managers for the emerging future trends in the construction industry.

SCM has helped many industries improve their performance and competitive capacity in today's global markets, especially the manufacturing sector. The construction industry can gain similar benefits, but this will require effective education of construction professionals and young engineers in SCM practices.

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SUSTAINABILITY FIRST

The green credentials of every participant in a supply chain must be considered for environmentally-conscious construction

When it comes to most industrial activities, the bulk of any environmental damage is caused by the supply chain. So, for sustainable construction to become a more mainstream concept, it is essential for contractors to examine not just their own green credentials, but those of their suppliers and subcontractors.

In today's competitive global market, the differentiation strategies required to participate in public sector infrastructure projects lie not only in a contractor's capacity to achieve the client's expectations, but also in its ability to meet new sustainability requirements. This additional criterion puts pressure on shareholders of engineering, procurement and construction (EPC) projects.

Well-tested, cost-effective construction techniques along with latest digital design tools and data processing technologies can enable contractors to meet the necessary standards of quality, within budget and on schedule. But

without the responsible management of the supply chain, the desirable sustainability objectives may not be achieved.

Committing to green

Acciona put in place a Global Sustainability Strategy in 2010, as part of its company strategy to contribute actively to social wellbeing and sustainable development.

This strategy is focused on optimum design and durability of infrastructure, mitigation of climate change and provision of solutions concerning water stress, and it is currently developed through the Sustainability Master Plan 2020, a road map that brings together all of the company's initiatives in this area with the clear objective of contributing to the achievement of the Sustainable Development Goals of the United Nations.

The company has implemented strategic and operative objectives for all of its current infrastructure, industrial and water projects in the UAE, for example the Jebel Ali desalination plant, to respond to the main challenges for

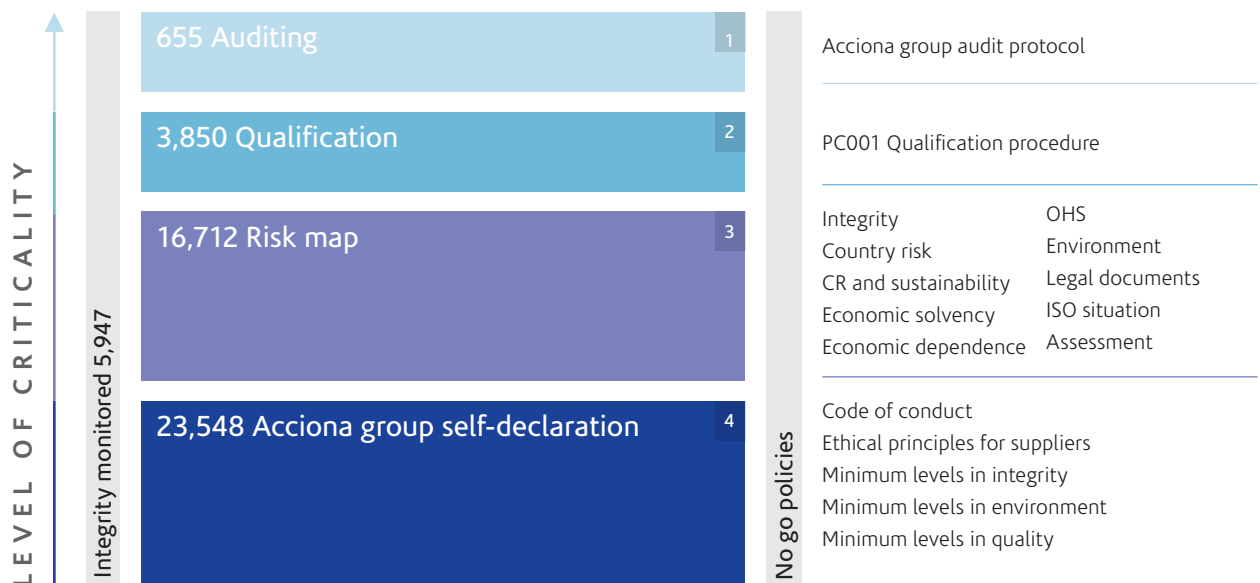


Figure 1: The control of the supply chain is established by levels of criticality, in a way that they are more exhaustive as the risks increase – economic, country, activity and CR and sustainability

Green supply chain

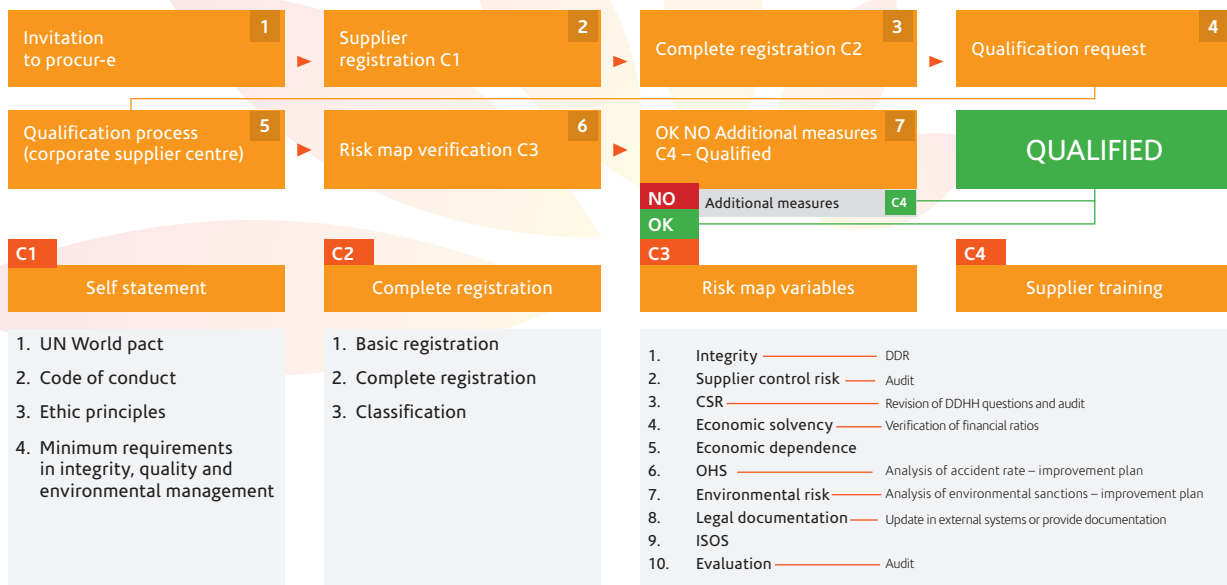


Figure 2: Acciona's supply chain qualification process controls, with verifications in each step to optimise risk management

sustainable development.

With the aim of identifying, mitigating and managing risk specifically within the supply chain, Acciona has an internal risk management mechanism that is essentially structured over three elements: The supply chain risk map, the supplier certification and evaluation procedure and the corporate procurement standard.

In-house tools

The supply chain risk map helps to identify and mitigate operational, political or economic risks, and creates greater efficiency in risk control, while also conveying a company's sustainability criteria and policies.

The supplier certification and evaluation procedure involves a full analysis of the suppliers, assessing factors such as corporate responsibility position, solvency or legal position, among others, as highlighted in figure 1.

The Procur-e platform used by Acciona is an electronic procurement tool to support management of the supply chain through its two functions: supplier portal and bidding tool. This ensures fair competence, confidentiality and transparency of the procurement process as all suppliers are given equal access to the shared information, highlighted in figure 2.

The mandatory 'self-declaration of responsibility' for company suppliers and subcontractors, the 'ethical principles for suppliers, contractors and partner', and the audits, evaluations and 'no-go policies' allow the detection at an early bidding stage of those subcontractors that do not

meet the minimum requirements to achieve the sustainability objectives.

Room for improvement

New technologies and software for supply chain management (SCM) are available to assist with real-time monitoring of the entire chain, including shipping and invoicing, encouraging a transparent supply chain performance.

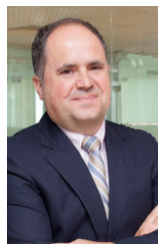
However, there is still room for improvement in the highly competitive market of international logistics, where large investments in innovative digital business models are currently being introduced by the new players.

Driving change

Contractors cannot deliver the required global transformation on their own. A priority on sustainability issues has to be established by the project owner in order to allow for the fair selection of the best contractor, in a process that is not based on the lowest-price criteria.

This could also be a great opportunity for the government and public sector to drive a significantly change in the way that large infrastructure projects are undertaken, as well as the chance to upskill the industry to meet a growing demand for sustainability.

ABOUT THE AUTHOR



Gonzalo de Córdoba is a regional procurement manager at Acciona Middle East

VIRTUAL WAREHOUSES

As construction undergoes massive digital disruption, clauses may need to be re-defined to account for inevitable changes in process

Additive manufacturing, often known as 3D printing, is a key component of the digital revolution that is transforming manufacturing. Advances in digital data technology are enabling on-demand production and decentralised manufacturing. They allow more integrated planning and production processes, which leads to improvements in product quality and a shorter supply chain.

One of the most exciting aspects of 3D printing is that it unlocks the potential for 'virtual warehousing'. Instead of manufacturers having to maintain a physical stock of components, they can instead store a digital file that can be printed when the part is required – a true, just-in-time manufacturing system that would have a massive impact on the supply chain for the construction industry.

Digital supply chain

The traditional model for the supply of spare parts comes with constraints such as the need for low-cost mass production, cheap labour and storage as well as equipment to move the components.

3D printing bypasses these issues with its low-volume production of customer-specific items.

This not only eliminates the need for large scale production facilities, heavy equipment and specialised tools, but also reduces the number of people involved on the shop floor in semi/unskilled labour.

Used properly, additive manufacturing lowers the costs related to machine downtime and eliminates the long lead-times and large orders necessitated by minimum order quantities (MOQs) frequently attached to the procurement of spare parts. The process creates almost zero waste and lowers the risk of overproduction and excess inventory, reducing the need for physical warehousing facilities.

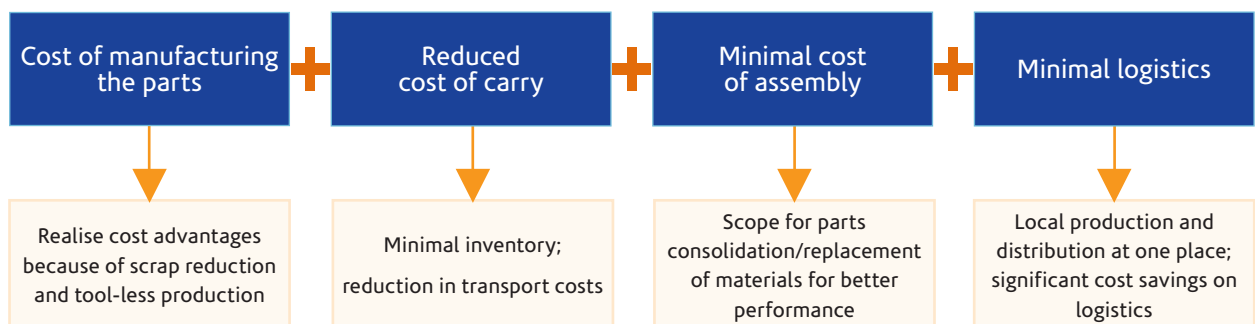
The entire value chain can be the part of a digital thread from the creation of the 3D file for the component, storage in a 3D digital file format and production of the part on demand using polymer/metal 3D printing machines. This will result in an agile supply chain that can rapidly adapt to changes in the market.

Construction companies in the region have shown considerable interest in adopting 3D printing technologies.

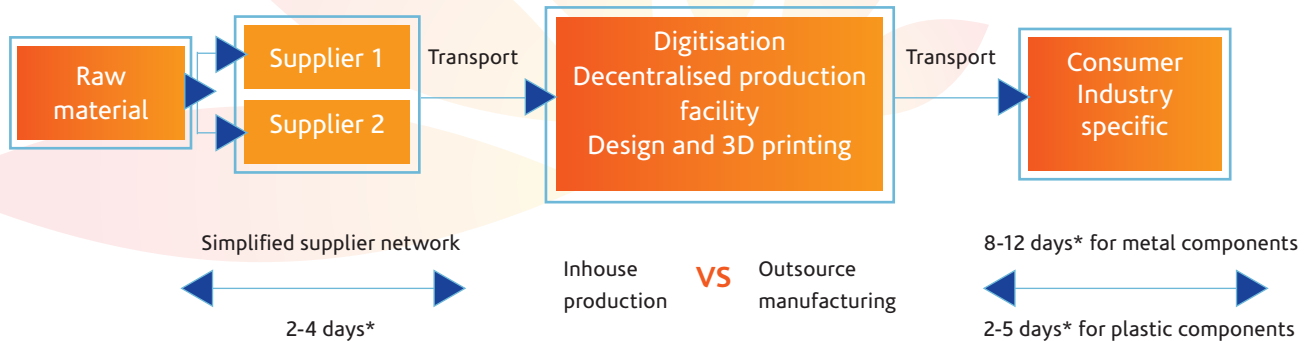
Traditional supply chain cost components



Smart supply chain cost components



3D printing-enabled supply chain for construction spare parts



*Timelines are purely an approximation and depend on part complexity, material used, quantities and the finish required

Recently, Arabian Construction Company (ACC) partnered with Abu Dhabi's 3DCreations to explore virtual warehouse concepts.

"After having initial experience with 3D printing of spare parts," says ACC's technical manager, Wael Boureslan. "We want to explore further the benefits it can bring to us like reduced lead times, cost per part and reducing the inventory needs."

Material choices

There are challenges to the large-scale adoption of 3D printing in the construction industry. Spare parts in this sector are mainly for earth moving, lifting and other heavy industry equipment. The dimensions of these parts can vary enormously and, currently, there are size restrictions on 3D printed metal spare components.

While some steel, nickel alloys and aluminium can be used for specific applications, there is a limited choice of financially viable, industry-specific materials suitable for metal additive manufacturing.

Significant levels of dimensional tolerances for functionality, part strength and other mechanical properties for the suitable application, can be met with the existing metal additive manufacturing solutions.

3D printing can be used to create a master patterns for investment and vacuum casting processes, providing a cheaper option for producing metal and plastic spare parts.

With polymer spare parts, most of the common plastic materials are available for 3D printing. However, post production work on the component may be required in order to achieve higher tolerances for form-and-fit functions, su-

perior surface finishes, and for repeatability of dimensional accuracy in high volumes.

To address some of these limitations, the design of spare parts could be improved with parts consolidation, topology optimisation or material replacement to enhance the performance of a product and bring it within the range of capabilities of 3D printing.

Barriers to change

There are challenges that must be overcome before we see a widespread adoption of additive manufacturing in the construction industry:

■ Acceptance

The construction industry is known for its resistance to change and an inability to embrace new technologies. Job loss is cited as a major concern that could be overcome by ensuring the full involvement of all employees during the implementation process, encouraging a sense of ownership of the technology.

■ Large initial investment

The high cost of production equipment such as concrete or metal printers, in addition to training and consultancy fees, is currently a barrier to adoption. There is also a lack of consistent fiscal benchmarking to evaluate the business benefits that would encourage investment.

Uptake could be improved with incentives such as government mandates and funding programmes for industry, academia and research. The development of methods for estimating and optimising costs and the provision of joint

FEASIBILITY STUDY AND COST ANALYSIS

The S.M.A.R.T Construction Research Group at New York University Abu Dhabi (NYUAD), led by Professor Borja Garcia de Soto, is studying the productivity and cost analysis of additive manufacturing in construction projects. One of the objectives of the group is to investigate the impact of 3D printing on the construction supply chain (CSC).

It is observed that although the number of participants in the CSC using 3D printing is not significantly different, their interactions and level of coordination at various stages has an impact on the lead time and production rate of the supply chain.

For example, during the design phase, extra effort is required to integrate features into the 3D printed elements, such as conduits for different MEP elements or architectural details. This leads to additional time being spent at that stage; however, the extra coordination pays off in subsequent phases of the supply chain by streamlining later processes and saving time during construction.

Based on ongoing simulations, preliminary results indicate that CSCs using 3D printing experience a reduction in the lead time (ranging from 15-18 per cent) and an increase in the production rate (ranging from 25-30 per cent) when compared to traditional CSCs.

“The high cost of production equipment such as concrete or metal printers, in addition to training and consultancy fees, is currently a barrier to adoption”

industry association partnerships could help to increase transparency and reduce costs.

■ Organisational change

Implementing any major change of process requires a company to re-evaluate and re-engineer its business practices. While this is often viewed as an inconvenience, it could be used as an opportunity to drive the development of new competencies and encourage businesses to improve project organisation.

■ Lack of developmental strategy and standards

Despite the relative maturity and availability of this technology, there are not enough quality standards available for spare parts to ensure that 3D printed components conform to industry specifications. It will take time however to fully understand the practical challenges of implementing new technology.

Pilot projects are providing useful information, and it is hoped that standards can be set once all of the stake-

holders have a full understanding of the technical issues such as accuracy and process repeatability.

Automation and artificial intelligence-enabled software could be used to monitor process repeatability, tracking and monitoring every stage of the value chain would ensure that standards are met.

■ Data security

With an ever-growing volume of data being collected, increasing demand for mobility and a trend for collaboration and information sharing, companies have valid concerns about the security of their digital information.

There are, however, many technologies available such as centralised, cloud-based, user-identity access management, device management and data protection tools that provide design protection, quality assurance and secure data distribution for the digital manufacturing value chain.

Overcoming these barriers requires collaboration between project stakeholders: developers, industry providers and various government bodies.

Initiatives such as the Dubai government's Dubai 3D Printing Strategy, the Saudi Arabia 3D Printing Strategy and work at the Sharjah Research and Innovation Park will be key to the successful adoption of 3D printing innovations in this region.

ABOUT THE AUTHOR



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COLLABORATED CHAIN

Intelligent 3D models provide a collaboration platform to maximise efficiencies, provide accurate budget estimates and ensure timely project delivery

There are few industries in the world that remain as fundamentally undisrupted by technology as the construction sector, resulting in high inefficiencies throughout the building process.

Large projects across asset classes typically take 20 per cent longer to finish than scheduled and can be up to 80 per cent over budget. According to a report from McKinsey Global Institute, lagging productivity in the construction sector costs the global economy a mammoth \$1.6tn every year - \$70bn of this lost economic value is borne by the Middle East construction sector.

And the challenges do not stop there. With rapid urbanisation, nearly 200,000 people move to cities every day. With the global population forecast to reach 10 billion by 2050, the pressure is mounting on the con-

struction industry to rethink its traditional approach. The growing population will need more large-scale projects with complex supply chains to ensure that demands are met.

However, with complex supply chains, human errors are rampant, collaboration becomes a nightmare and the risk of resource wastage is increased many times. It is estimated that an alarming 30 per cent of global solid waste comes from construction. This, coupled with limited natural resources, is a major call for the industry to build more, using less.

Coordinated efforts

Building information modelling (BIM) is an intelligent 3D modelling process that provides an ideal platform for collaboration between different stakeholders through-

out a project. For instance, it provides a centralised design repository for architectural, civil and mechanical, electrical and plumbing (MEP) designers to collaborate during the project lifecycle. BIM coordinated design significantly reduces the number of clashes and rework on site by providing proactive controls to all the members of the supply chain.

This allows accurate estimation and timely delivery, both of which have a significant impact on the financial and environmental costs of a development.

BIM also helps stakeholders to align their designs and reduce clashes. For instance, MEP designs can conflict with the civil structure as 2D drawing overlap often goes unnoticed until the construction phase, when it becomes difficult and expensive to remedy. Using BIM, clashes can be flagged by the software ensuring that all parties can envision the final product.

Autodesk has extended, cloud-based BIM workflows on projects such as the Museum of the Future in Dubai and Louvre Abu Dhabi, where remote teams around the world contributing to the successful and timely completion of the project, are able to collaborate design and planning work through a single centralised work share.

During the development of Louvre Abu Dhabi, more than 1,000 employees of Austria's Waagner-Biro used BIM in 16 locations across Europe, the Middle East and South-East Asia to design the complex structure of steel and glass without having to travel around the world to physically collaborate with the different stakeholders. With a traditional, unconnected, 2D-based workflow, such a project would have cost more and taken longer to complete.

Reaching new heights

Even though BIM is helping architects, engineers, developers, contractors and building consultants to collaborate more effectively, taking efficiency to unprecedented levels, the technology is yet to reach its full potential.

With every construction project, more data is generated than companies are able to process for meaningful

“... With complex supply chains, human errors are rampant, collaboration becomes a nightmare and the risk of resource wastage is increased many times”



insights. This is where machine learning (ML) and artificial intelligence (AI) can play a role.

For example, if a project has a thousand quality issues on a construction jobsite, no human would be able to extract knowledge from all of the issues to enable better decision making. Tools such as Construction IQ consider various factors about the project stakeholders, such as their past behaviour during issue management, current workload and the importance of the issue.

It then assigns a 'risk score' to each party in the project, a metric to indicate the amount of risk that they currently pose to the project, so that the construction managers can better prioritise their time to work more closely with high-risk teams.

For future projects, projects owners can select their supply chain based on their risk score and ensure the best delivery of the project.

With the use of BIM and AI/ML tools, costs, labour, emissions, time-taken and waste during construction can be reduced dramatically.

As cities in the future will be home to 70 per cent of the world's population, the complexities involved in building cities will demand smarter, more connected technologies such as BIM along with smarter design approaches. The supply chain will evolve to become smarter, more efficient and environmentally friendly as the adoption of BIM accelerates.

ABOUT THE AUTHOR



Naji Atallah is the head of AEC and manufacturing at Autodesk

BUILDING BLOCKS OF SUCCESS

The traditional model of construction is being disrupted by modular methods that save costs, reduce waste and deliver better efficiency

The urban population in the region has increased dramatically in recent years. With this trend set to continue, there is huge pressure on exiting housing, schools and hospitals. The urgent need to construct new facilities is driving a demand for rapid, scalable building methods that do not compromise quality and require fewer resources.

Offsite construction

These requirements could be met by prefabricated, prefinished volumetric concrete (PPVC) construction methodology, which is a process by which the building is subdivided into smaller units called modules, which are designed and manufactured offsite in a factory. Modules in various stages of completion form a production line that progresses from assembly to complete fit-out.

Amana Group's subsidiary DuBox designs and delivers single and multi-storey concrete buildings, using PPVC construction methodologies. With manufacturing facilities in both UAE and Saudi Arabia, DuBox produces prefinished,

precast concrete modules that are later transported to the site. Entire concrete buildings are manufactured offsite in DuBox's factory.

3D volumetric solutions are fully fitted-out units that can be assembled on site like a series of Lego bricks. Onsite assembly involves lifting the modules into position and connecting services such as electrical and plumbing. This transformation of construction methodology reduces the project delivery timeline as activities are performed in parallel.

Manufacturing in a controlled factory environment shifts 85 per cent of construction activities from the site to a factory, leading to shortened build times, earlier return on investment and minimal impact on the environment. Such features of modular construction are seriously disrupting the conventional methodologies of onsite construction.

DuBox was contracted to construct 26 villas in Dubai's Al Diyafah Village for Al-Futtaim Real Estate using a modular volumetric concrete precast design and offsite manufacturing. The villas were built in only 320 days – 104 days ahead of schedule, taking only 12.5 days per villa.

Despite being located in the busy neighbourhood of Al Jaffiliya, the project was completed with minimal disturbance to the local community.


Total cost savings

When looking at the cost of a project, it is important to focus on the full-life cost, not just the construction cost. The increased precision of construction due to transferring site activities to a controlled processed environment can have a significant impact on the performance of the building in terms of durability and operational cost.

A modular approach to construction can also improve quality. Every construction site presents challenges when it comes to control of resources, manpower and wastage, not to mention the logistics and exposed open environment. Offsite construction in a manufacturing environment can drastically improve the quality of the structure and ensures consistent standards throughout the project.

Productivity is also drastically boosted – an important consideration for the sector's economic growth – and this means lower costs for construction companies and better value for end-users.



 DuBox constructed 26 villas in Dubai's Al Diyafah village using modular construction methods



The question that remains is: how can modular solutions be balanced with conventional onsite practices to optimise the supply chain?

Site overheads

PPVC has a proven track record in reducing the duration of projects, coupled with a transformational shift of processes to a controlled environment that dramatically lowers site overheads for all stakeholders, including the client, consultant and contractor.

Materials

Centralising procurement in a manufacturing facility can control material cost overrun. This is enabled by direct procurement for all materials, which optimises deliveries, thus reducing logistics costs. There are also benefits in terms of the economy of scale for purchasing via a centralised channel in the manufacturing facility.

Additionally, a factory production process has far lower wastage rates than an open construction site, potentially reducing material waste by 30 per cent – not to mention eliminating the need for site storage, which has big advantages in limited and restricted areas.

Environmental benefits

Traditional construction practices have a significant impact on the ambient environment. From disrupting the site with excavation and building processes, to the unchecked consumption of materials and the subsequent dumping of waste in landfills. The entire cycle results in enormous waste and carbon emissions, calling for a new approach to construction.

This is where modular building solutions could play an important role. While reducing carbon emissions and waste, the use of modular buildings also offers flexibility when it comes to relocation and decommissioning. Modular buildings can be designed to be moved and reused as required, providing significant reduction in long-term costs and carbon footprint.

PROJECTS THAT COULD BENEFIT FROM MODULAR CONSTRUCTION

- Residential developments – villas, medium to low-rise residential complexes and student/staff accommodation
- Hospitality – hotels, resorts and serviced apartments
- Healthcare buildings – hospitals, clinics and medical centres in remote areas
- Educational institutions – kindergarten to year 12, technical institutions, universities and special education centres

Labour force

Modular build shifts 80 per cent of traditional labour activity to a controlled manufacturing facility. This type of standardised operating environment can double productivity compared to traditional site construction thanks to the repetitive, simplified process, and elimination of site downtime. Onsite building assembly requires less manpower due to drastically reduced site activities.

This process can reduce labour costs on a project by 30 per cent, with even higher savings depending on the project's scalability and level of complexity for activities shifted offsite.

Expert delivery

While offsite construction manufacturing of volumetric concrete modules might sound like a straightforward job, its disruptive processes require more expertise and quality control than traditional building techniques, such as in-situ construction. Not every company will be adequately equipped to deliver modular construction projects.

Having worked on projects worth more than AED1bn (\$272.3m) for clients including Saudi Arabia's AlMarai, Qiddiya Investment Company and Red Sea Development Company, and the UAE's Al-Futtaim Real Estate, Wasl Asset Management Group, Esol Education, Emaar and Abu Dhabi National Oil Company (Adnoc), DuBox is on a mission to promote PPVC methodologies in the region. DuBox uses social media to engage with the general public – regularly answering queries on Instagram, for example – and publishes case study videos as part of its awareness campaign.

ABOUT THE AUTHOR



Chebel Bsaibes is the chairman of Amana Group

MANAGING ASSETS BETTER

With tightening margins and restricted budgets, contractors can cut down project costs with effective management of staff, equipment and material

Contractors face losing of millions of dollars every year as a result of misplaced, stolen or poorly maintained assets. Time is frequently wasted locating materials or fixing equipment, which has a negative impact on project schedules. In these competitive times, when contracts are both price and time sensitive, it is essential for industry professionals to adopt a more effective asset management system.

The construction sector has a huge impact on the region's economy. According to project tracking database MEED Projects, the value of construction and transport projects planned or under way in the GCC at the end of June 2019 was about \$1.2 trillion. Approximately \$22.4bn of construction and transport project contracts were awarded in the GCC during the first half of 2019.

With so much at stake, there is a need to address the problems that plague the industry, a major issue being poor supply chain and asset management. This is one of the key issues we try to solve at Trimble, by providing purpose-built and optimised solutions that serve the entire

building lifecycle. We find that by uniting hardware, software, and services, we are able to create a constructible process that enables frictionless communication amongst stakeholders and smoother workflows.

Centralised control

Physical assets can be described as premises, tools, vehicles, and even on-site labour. Effective control of these resources is crucial for almost every business, not just those in the construction industry, and efficient, optimised construction supply chain management could lead to huge savings.

Contractors are increasingly turning to smart technology and internet of things (IoT) to enable effective planning and coordination. They realise that it is possible to monitor the construction workflow at every step of the life cycle, enabling companies to track and manage their assets, materials, equipment and even labour, using smart, integrated asset management tools. All that remains is ensuring uniform and widespread adoption of such tools, to deliver best results.



“Contractors are increasingly turning to smart technology and internet of things (IoT) to enable effective planning and coordination”

Tracking the workforce

The practice of mass-populating construction sites to meet schedules is becoming less common. Skill and labour shortages are driving the need for improved jobsite management, which means making sure that appropriate, certified staff are at the correct locations at the required time.

Systems that use radio frequency identification (RFID) are increasing being used to monitor staff access points. Technology of this type improves safety onsite, enhances control of staffing costs and provides better control of the workflow, as it enables construction managers to monitor the location of each worker, manage the time they spend on a typical task and allocate jobs accordingly.

The technology can also be implemented to monitor other tools and assets on a worksite, for example, making it possible to check on equipment location and availability.

Monitoring tools

Although construction is an increasingly hi-tech industry, the way many companies manage heavy equipment and machinery has not moved with the times. Firms make a large initial investment on equipment, but are reluctant to spend further on management and maintenance. Instead of making use of integrated, digital systems, they expect managers to work with manual, paper-based processes.

The financial implications of poor equipment management don't seem significant at the early stages of a project, but the cumulative cost related to machinery malfunction becomes significant as construction nears completion.

The implementation of modern maintenance practices may seem like an unnecessary expense, but it generally leads to significant savings in the longer term.

BIM coordination

In this competitive market, the supply chain must be managed throughout the different processes and activities of a project life cycle. Besides managing the labour, equipment and assets, effective management of the inventory and raw construction materials is also crucial. Building information modelling (BIM) systems are being increasing-



ly used to monitor and control supply chains, along with many other aspects of the construction process.

A BIM modelling system uses a digital 3D rendering of a building that can be shared with all of the project stakeholders to provide real-time information on almost every aspect of a development from the initial design phase, through to handover and beyond.

For example, a well-established steel rebar product supplier in the region is currently making effective use of BIM technology to eliminate wastage in their rebar cut and bend workflow.

In order to minimise the amount of material that is needed to manufacture the product, it uses data from 3D models to calculate precisely where the rebar needs to be cut and bent. This information is sent directly to the computer numerical control (CNC) machines, enabling them to achieve maximum efficiency.

Coordination is key to effective supply chain management, which is highly complex for the construction sector due to the fact that every building project is unique and involves a large team of consultants, contractors and suppliers.

Fortunately, we are living in an era where technology such as BIM, blockchain and IoT is driving the construction industry forward, and it's just a matter of time before issues like labour shortage, material wastage and poor asset management become a thing of the past.

ABOUT THE AUTHOR



Paul Wallet is the regional director of Trimble Middle East and India

THE WAY AHEAD

Construction projects are bespoke efforts that can benefit from a long-term and collaborative approach to delivery



The construction industry can benefit from an integrated and collaborative approach to project delivery. To establish a stronger supply chain, it is necessary to have long-term approach to relationships in construction. These partnerships need to extend beyond a project contract and need to be strategic in nature.

Successful implementation of supply chain management (SCM) principles can meet the above need, while also improving transparency and efficiency in the industry. Clients can identify the opportunities and challenges in the supply chain and accordingly manage the cashflow. Meanwhile, contractors can engage in and improve communications with the client. They establish long-term relationships with their suppliers and subcontractors, and work in tandem to deliver projects.

Strategic management of a project supply chain will typically see suppliers being prequalified across a range of services without having to bid for each and every contract.

McKinsey Global Institute's report *Reinventing construction: A route to higher productivity* highlights that digitising procurement and supply-chain work flows will enable more sophisticated logistics management and just-in-time delivery in the construction sector. E-procurement can automate the entire procurement procedure, reducing the dependency on manual and paper-based processes.

One way that project owners can reduce waste from the

entire lifecycle of their construction projects is to communicate and consult with the stakeholders in their supply chain as early as possible, starting from the design stage.

By accommodating to reduce waste right from the design stage, clients can allow the design firm to use their own experience and plan in different ways that will use less waste or allow for reusable materials. This could be included as a criteria in the tender requirements for potential design teams.

While on the construction site, waste can be minimised by managing purchases and encouraging reuse wherever possible. Tenders could require prospective contractors to indicate the likely waste recovery targets and KPIs that can be achieved on the project.

Furthermore, practices such as additive manufacturing, prefabrication and off-site construction, and asset management can offer considerable savings while boosting delivery times.

Prefabrication particularly can enable a 'production line' for construction, reducing a project's delivery times, costs relative to traditional construction methods and create safer working environments.

Post the construction phase, better operations and maintenance (O&M) will be achieved if better practices are included right from the design stage of the project. This can be enhanced by feed in data into BIM models throughout the project lifecycle and using this in the O&M stage.



ABOUT MEED

MEED has been integral to delivering business information, news, intelligence and analysis on the Middle East economies and activities for over 60 years. Attracting a key senior management audience through its content and activities, MEED is a media brand, publication and data business that covers a spectrum of services which inform, engage, connect and ultimately support our subscribers and partners in their business development and strategic growth.

Recently acquired by GlobalData Plc, MEED is now part of one of the largest data and insights solution providers in the world with the capacity to build global communities for our clients.

Our purpose is to support the region's companies make better and more timely decisions through our innovative data solutions and grow through our comprehensive and world-class marketing solutions.

To find out more email: info@meed.com

ABOUT MASHREQ

Established in 1967, Mashreq is the oldest bank in the UAE, with award-winning financial solutions and services. Throughout its 50 years' history, Mashreq has differentiated itself through innovative financial solutions, making it possible for its customers to achieve their aspirations.

Today, Mashreq has a significant presence in 11 countries outside the UAE, with 21 overseas branches and offices across Europe, the US, Asia and Africa.

Mashreq launched its new Vision and Mission recently, outlining its commitment towards its clients, colleagues and the community. In line with its vision to be the region's most progressive bank, Mashreq leverages its leadership position in the banking industry to enable innovative possibilities and solutions for its customers across corporate, retail, international, treasury and Islamic banking.

Mashreq is proud to be the first financial institution in the UAE to be awarded the Gallup Great Workplace Award for four consecutive years from 2014-17. Mashreq also continues to invest in recruiting, training and developing future generations of UAE national bankers.

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