

Cambridge Centre
for Housing &
Planning Research

Industry guidance: successful adoption and use of BIM and OSM

Dr Kwadwo Oti-Sarpong
Dr Reyhaneh Shojaei

January 2021

Dr Kwadwo Oti-Sarpong
Dr Reyhaneh Shojaei
PI: Dr Gemma Burgess
Cambridge Centre for Housing & Planning Research
Department of Land Economy
University of Cambridge
19 Silver Street
Cambridge
CB3 9EP

ko363@cam.ac.uk
rss64@cam.ac.uk

www.cchpr.landecon.cam.ac.uk

Contents

1. Introduction.....	1
2. What does it take to successfully adopt and use digital technologies and offsite manufacturing?	3
3. Committed leadership and management.....	4
4. A digital transformation strategy with realistic objectives	7
5. Building a capable supplier network through a 'growing together' approach.....	10
6. Building trust-based relationships with clients.....	13
7. Training and skills development initiatives for employees.	15
8. Robust structures for effective collaboration and communication	17
9. Conclusion	20

1. Introduction

1.1. Background

The UK construction industry has been frequently berated for its problems of low productivity, delays, unsafe work practices and the delivery of projects that exceed planned costs¹. To tackle these problems, the Government² has ramped up efforts to drive an increase in the use of digital technologies and manufacturing approaches for delivering construction projects and managing built assets. Building Information Modelling (BIM)³ and Offsite Manufacturing (OSM)⁴ have been put forward as the two key innovations that can be used to deliver projects faster, cheaper, safer and at higher quality. The current Industrial Strategy (IS), the Construction Sector Deal⁵, outlines the Government's partnership with industry to promote the use of BIM and OSM to reduce construction and whole lifecycle asset costs by over a third, reduce delays in construction project delivery and greenhouse gas emissions by half in 2030. The Construction Playbook, recently published by the Cabinet Office⁶, sets out how the Government is prioritising the deployment of these innovations through public sector procurement in order to make their use mainstream in the construction industry.

For any of these goals to be achieved, the construction industry needs to embrace the use of BIM and OSM on a large scale. However, this will only happen if construction firms (i.e., consultants, general contractors, specialist subcontractors) are able to adopt and use BIM and OSM successfully. Despite this critical need for engagement, both take up and use remain low. There are several reasons for this⁷, and the lack of evidence of the 'real' benefits of the use of BIM and OSM has made construction firms reluctant to embrace their adoption⁸.

¹ Wolstenholme, A. (2009). Never waste a good crisis: A review of progress since Rethinking Construction. London: Constructing Excellence.

² HM Government (2013). Industrial Strategy – Government and Industry in practice. Construction 2025. London: HM Government.

³ IPA (2016). Government Construction Strategy 2016–20. London: IPA.

⁴ IPA (2019). Proposal for a New Approach to Building: Call for Evidence. Infrastructure and Projects Authority. London: IPA.

⁵ HM Government (2018). Industrial Strategy – Construction Sector Deal. London: HM Government.

⁶ Cabinet Office (2020). The Construction Playbook. London: Crown. Accessed on 11 Dec. 2020 via: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/941536/The_Construction_Playbook.pdf

⁷ CLC (2016). Roadmap for Modern Methods of Construction (MMC) Workshop Report. Construction Leadership Council Innovation Workstream (Buildings). Issue 1.0, April 2016. Construction Leadership Council.

⁸ House of Lords (2018). Off-site manufacture for construction: Building for change – Oral and written evidence presented to the UK House of Lords. London.

Despite this, some construction firms are successfully using BIM and OSM. The experiences of these firms can provide useful learning for other construction firms.

1.2. About this guidance

This guidance document describes six key factors that will help construction firms to transform their project delivery through the adoption and use of BIM and OSM. Our research has shown that construction firms that have successfully adopted and are using BIM and OSM share six common characteristics:

- committed leadership and management;
- a digital transformation strategy with realistic objectives;
- competent supplier networks built through a 'growing together' approach;
- trust-based relationships with their clients;
- well-developed training and skills development initiatives for employees; and
- robust structures for effective collaboration and communication.

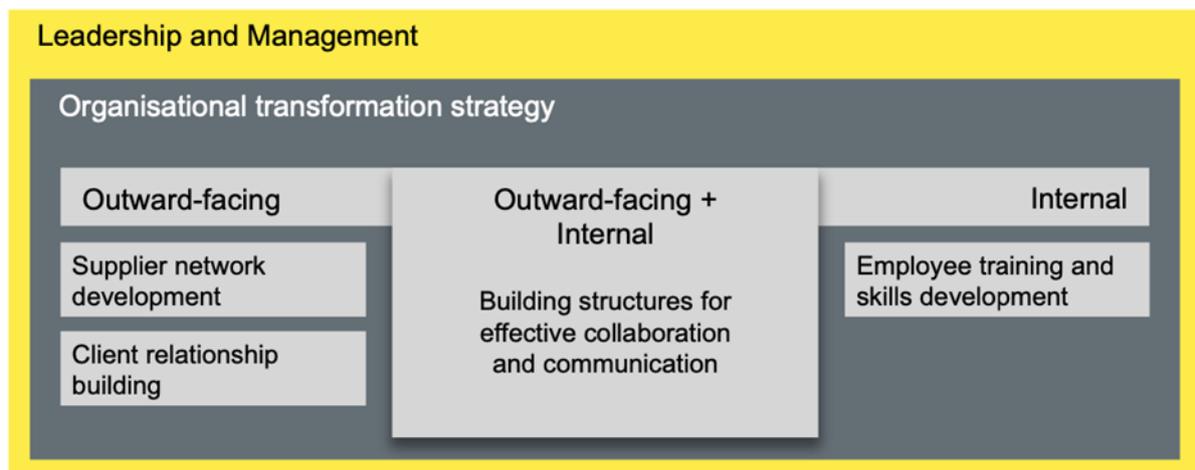
The insights shared in this guidance draw on interviews with over 40 construction industry stakeholders in the UK (contractors, consultants and clients) who have undertaken commercial, residential and infrastructure projects across the country and overseas.

Nine recommendations are put forward in this guidance document. Designed to guide construction firms taking steps to adopt and use BIM and OSM, the recommendations are specifically targeted at senior executives and managers of construction firms, regardless of size, who can implement initiatives to enable their firms to adopt and use BIM and OSM, or improve what is already in place.

2. What does it take to successfully adopt and use digital technologies and offsite manufacturing?

Figure 1 illustrates how the leadership and management of a firm is crucial for creating a framework within which all the other factors can be implemented. It also shows how implementation of these factors has both internal and external implications for firms.

Figure 1: Enabling factors



In the sections that follow, each factor is described and supported by relevant industry examples and key recommendations for implementation by other construction firms.

3. Committed leadership and management

A firm needs committed leadership to support the process of change. Having a leader who will champion the digital transformation vision within a firm is essential for success⁹.

A transformation agenda cannot focus solely on technology but must consider individual practices and internal culture in order to successfully establish new ways of working among employees. For a transformation strategy to 'trickle down' through a firm, leaders need to believe in the strategies they are implementing. A leader-champion can be an executive or manager who believes in the urgency of digital transformation, its long-term benefits and who is committed to implementing the necessary strategies to achieve the vision. This will involve communicating the digital strategy and vision in ways that appeal to employees and their work-related aspirations. Engagement needs to be personalised and people-focused, and spearheaded by a manager (or committee) who understands this and is able to communicate clearly and coherently across all areas of the firm and its supply chain.

A supportive leadership culture values employee suggestions. Ensuring that input from employees is treated in a way that shows that they are valued is important, because this has a direct impact on employees' willingness to be a part of the transformation – a factor that can either constrain or facilitate digital transformation. When employees see that their suggestions have been implemented in a company's practices, it can boost their participation in the digitalisation agenda. To ensure that employees are genuinely involved in the transformation journey, it is crucial for management to communicate regularly and clearly with employees, and be open to receiving feedback. This is important for successful digital transformation.

Leadership training resources are available through the Construction Industry Training Board's (CITB) three-years funded scheme, 'Giving leaders the skills to drive digital transformation'¹⁰, the National Construction College's (NCC) Management and supervisory courses¹¹, and the Supply Chain Sustainability School's range of courses,¹² all designed to give leaders in construction firms the skills to drive digital transformation.

⁹ <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/how-to-become-tech-forward-a-technology-transformation-approach-that-works>

¹⁰ <https://www.citb.co.uk/about-citb/news-events-and-blogs/uk/2019/10/news-detail1/>

¹¹ <https://www.citb.co.uk/national-construction-college/leadership-and-management/>

¹² <https://learn.supplychainschool.co.uk/local/tlactionplans/resources.php?term=leadership>

3.1. Industry example 1: Multiplex

Multiplex is a leading global construction company operating in Australia, India, Canada, Europe and the Middle East that uses innovative technologies to execute large-scale and complex projects in residential, mixed-use, education, health and civil infrastructure developments. The firm employs over 6000 people¹³. Based on its latest turnover, it ranks 19th in the top 100 UK construction companies list¹⁴. In 2019, Multiplex were judged to be the 'Most Innovative Contractor' at the Building Innovation Awards¹⁵.

According to their Digital Transformation Executive, Fred Bloggs, much of Multiplex's efforts have focused on employee engagement and cultural change. Multiplex's leadership strategy is people-focused and guides their digital transformation agenda. Where new technologies and practices are introduced, employees are treated as individuals and their career aspirations are taken into consideration in parallel with the task changes that will need to take place.

Internal and external innovation competitions are used as a strategy for motivating employees to gain recognition for digital innovation. Internal competitions recognise project teams that have, over a year, been able to meet specific targets related to the use of digital technologies. Recognition by external industry awards also 'serves as a big boost for the team since they know they are working in one of the best firms in the industry when it comes to using these digital innovations'.

3.2. Recommendations

Appoint a digital transformation leader-champion

It is crucial for construction firms to appoint a person (or team) who will champion the transformation vision and who is committed to the urgency of digital transformation and who will drive and oversee the implementation of a digital transformation plan. The leader-champion needs to hold an executive or management position, as this creates employee confidence in the transformation vision and agenda.

¹³ https://3zt0kb2y7cm937csd513ok8u-wpengine.netdna-ssl.com/wp-content/uploads/2019/11/MPX-Corporate-Profile-2019_FINLR_Nov19.pdf

¹⁴ <https://www.theconstructionindex.co.uk/market-data/top-100-construction-companies/2020>

¹⁵ <https://buildinginnovationawards.co.uk/2019-winners/>

Lead by example

Senior executives and managers in construction firms implementing a digital transformation plan should aim to drive the vision internally at every opportunity and on all projects. Leadership by example demonstrates commitment to the digital transformation agenda, showing how the vision can be realised through everyday internal and project-related activities. Leaders should foster employee confidence in the vision, the implementation strategy and the expected outcomes from the transformation journey.

Lead people, don't focus solely on technology

Whilst getting the right technology is important, focusing attention solely on technology tends to relegate an important aspect of achieving digital transformation – changing people's perspectives.

It is important to develop a leadership plan that focuses on enabling people to fulfil their potential whilst embracing the use of new technologies. Leadership that focuses on changing the minds of people by appealing to their individual, work-related aspirational goals enables employees to achieve goals for the use of digital technologies.

4. A digital transformation strategy with realistic objectives

A digital transformation strategy is a plan that shows where a firm is at, outlines a vision of change and provides guidance for how that change will be achieved in the future. A clear digital transformation strategy should be developed and implemented by construction firms seeking to make greater use of digital technologies and OSM^{16,17}.

A successful digital transformation strategy provides a step-by-step map of how to create a new firm culture around the use of new technologies¹⁸. Tools are available to help firms assess their current digital capabilities and competencies and to benchmark them against potential competitors so that future actions can be improved^{19,20}. Construction firms seeking to undergo a digital transformation will benefit from undertaking such an assessment prior to developing their digital transformation strategy²¹.

A digital strategy should be geared towards establishing new routines and practices and creating a new firm culture, with a focus on people, processes, routines and technology²².

Our research suggests that a digital strategy that achieves transformation:

- uses simple language to communicate the goal of transformation;
- gives employees a sense of 'shared ownership' in what is to be achieved;
- is consistent and can be repeated across the firm;
- considers the needs of people (employees) in introducing new technologies and processes; and

¹⁶ <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/decoding-digital-transformation-in-construction>

¹⁷ McKinsey & Company (2020) The next normal in construction. Accessible via: https://www.mckinsey.com/~media/McKinsey/Industries/Capital%20Projects%20and%20Infrastructure/Our%20Insights/The%20next%20normal%20in%20construction/executive-summary_the-next-normal-in-construction.pdf

¹⁸ Oliver Wyman (2018). The time is right to set up a real digital strategy in construction. Accessible via: https://www.mmc.com/content/dam/mmc-web/Files/OliverWyman_Digitalization_in_the_construction_industry_web_final.pdf

¹⁹ <https://i40-self-assessment.pwc.de/i40/landing/>

²⁰ <https://www.supplychainschool.co.uk/topics/bim/>

²¹ RICS (2020). How to create a digital culture in a construction firm. Accessible via: <https://www.rics.org/uk/news-insight/future-of-surveying/data-technology/create-a-digital-culture/>

²² McKinsey & Company (2019). Decoding digital transformation in construction. Accessible via: <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/decoding-digital-transformation-in-construction>

- provides the needed internal support structures for implementation (e.g., training and support for staff, appropriate software).

4.1. Industry example 2: Willmott Dixon

Willmott Dixon (WD) is a leading, multi-award-winning UK construction company²³ that ranks 14th among the UK Top 100 construction companies²⁴. The firm has over 3000 employees involved in its residential and non-residential construction, interior fit-out and refurbishment projects.

At Willmott Dixon, there is a national digital strategy for all its businesses. Core to this strategy is the use of BIM as Business-as-Usual for all projects, regardless of clients' requests. Divisional and regional managers are responsible for adhering to this and are tasked with effectively and consistently communicating the strategy to their teams. Digital managers from its six regional Local Construction Offices (LCOs) contribute to this strategy by proposing additional local strategies that align to the national digital.

This approach enables direct employee input to feed into the development of the national Willmott Dixon digital strategy, given the large size of the firm, and allows LCOs to incorporate any unique digital needs of clients and projects into the overarching national digital strategy through the local strategy. The national and local strategies are therefore aligned to achieve the same transformation objectives.

The incorporation of local digital strategies by the LCOs has created an avenue for employees to propose new digital technologies for consideration. Prior to adoption, new technologies are examined to ascertain their fit with the company's strategic goals and processes. This step provides an opportunity to establish the individual and collective benefits for internal operations and on projects. This creates an awareness among employees of the positive benefits yielded by the digital strategy at the local level and across the entire firm.

²³ <https://www.willmottdixon.co.uk/awards?page=4>

²⁴ The Construction Index (2020). Top 100 Construction Companies 2020. Accessible via: <https://www.theconstructionindex.co.uk/news/view/top-100-construction-companies-2020>

4.2. Recommendation

Design a simple, clear and people-focused digital transformation strategy that can be easily communicated

Construction firms, regardless of size, need to develop a digital strategy that sets out realistic transformation objectives in plain language. It should be simple, easy to understand and consistent. It should be consistently communicated across all levels and areas of a firm, and repeated until a new firm culture has been established.

It is very important that senior executives and management support and drive the development of the strategy alongside their employees. Jointly creating a digital transformation strategy is critical for ensuring that employees have shared ownership of the vision and objectives that the strategy articulates.

5. Building a capable supplier network through a 'growing together' approach

Construction firms need to ensure their supply chain has the necessary skills and capabilities to deliver projects using BIM and OSM. To achieve this, they may need to support their supply chain to develop these capabilities.

Firms operating as suppliers in the construction supply chain are critical for successful project execution as contractors are heavily reliant on their supplier networks, including general/specialist (trade) subcontractors. Whilst some contractors have developed capabilities to use BIM and OSM, not all of the firms they work with in their supplier networks will have such capabilities. The successful use of BIM and OSM on projects requires that suppliers also have the necessary level of skills and capabilities. This may involve firms helping to equip subcontractors so that they can use the same or similar hardware and software or tools when working on projects using BIM and OSM. There are resources available for construction firms to assess their supplier network needs^{25,26} as part of their digital transformation programmes.

Some of the large contractors interviewed are adopting a 'growing together' approach to build and upskill a supplier network with the necessary capabilities for working on projects that involve the use of BIM and OSM. This supportive approach involves hosting workshops, training sessions and company visits to learn of capability challenges and to offer training support to suppliers. By adopting this approach, firms have learned about the challenges faced by their suppliers in terms of the digital skills of their staff, hardware, software and training needs, and as a result they have offered bespoke assistance to address these needs. This approach has also enabled contractors to share the digital and manufacturing capabilities needed for future projects. This transparency ensures that supplier firms are aware of what they will need to keep working on projects with the contractors, and is considered to be a 'win-win' approach to building a competent supplier network. The 'growing together' approach has proven to be particularly useful for construction firms seeking to make the transition to using BIM and OSM with their supplier network, building on working relationships that have developed over the years.

²⁵ Deloitte (2017). Disrupting business models – Digital Supply Networks. Accessible via: <https://www2.deloitte.com/global/en/pages/operations/solutions/gx-digital-supply-networks.html>

²⁶ <https://www.supplychainschool.co.uk/topics/bim/>

5.1. Industry example 3: Skanska

Skanska is one of the world's leading construction and project development companies, operating in the residential and commercial property sectors in the Nordic region, Europe and USA; Skanska has around 34,000 employees²⁷. Based on their latest turnover, this multi-award-winning company ranks 13th among the UK Top 100 construction companies²⁸.

With their supply chain delivering around 80% of the company's turnover, Skanska's digital capability relies heavily on supply chain transformation. Skanska recognises the need to support its supply chain as part of successfully implementing its digital transformation strategy. The firm is eager to maintain their longstanding working relationships with these suppliers because they have built a lot of trust with them. Part of their approach involves providing their suppliers with access to training offered by the Supply Chain Sustainability School²⁹ – of which Skanska is a founding member, in partnership with the CITB. The fact that the resources provided are free to use removes one of the major barriers to upskilling the supply chain.

Another of Skanska's strategies involves increasingly challenging their supplier network partners to explore the use of new technologies on projects. Skanska encourages their suppliers to develop the capabilities needed to work with them using these technologies, using a strategy called 'innovation-push'.

A 'growing together' strategy involves providing the requisite training, workshops and regular communication necessary to inform firms in their supplier network about digital technologies that can be adopted for doing things more quickly and with less labour, as well as how to use more off-site approaches. This provides Skanska with opportunities to keep their supply chain partners informed about the digital capabilities required for specific projects. Continuous engagement with their supplier network partners means that Skanska is able to learn about capability gaps and support them in a learning process towards improvement. This focus on developing their supplier networks has been a key component for the successful implementation of projects using BIM and OSM.

²⁷ <https://group.skanska.com/about-us/skanska-in-brief/>

²⁸ <https://www.theconstructionindex.co.uk/news/view/top-100-construction-companies-2020>

²⁹ <https://www.supplychainschool.co.uk/>

5.2. Recommendation

Support your supply chain to develop their digital and OSM capabilities

Large contractors should aim to assist firms in their existing supplier networks to improve or build capabilities in using BIM and OSM for projects. Doing so will save time and resources in establishing new working relationships and in building trust with other firms they may not know well. It is therefore helpful to support trustworthy and high-performing suppliers to develop relevant capabilities for using digital technologies and OSM.

This 'growing together' approach can be achieved through the hosting of workshops and training sessions with subcontractors in order to understand their needs and jointly develop plans to help their development. There are mutual benefits to be gained in doing this. A strong supplier network equipped with digital and manufacturing capabilities is crucial in demonstrating relevant capacity at the tendering stage of projects, and critical for successful project delivery.

6. Building trust-based relationships with clients

Clients are key players who can drive innovation in the industry, and obtaining their buy-in is crucial in order to increase the use of digital technologies and offsite manufacturing. This is particularly important for private sector clients who are under no obligation to use any specific technology or approach for their projects, unlike public sector clients who are obliged to require the use of BIM³⁰, and to give a presumption in favour of using OSM, where it could lead to value for money³¹.

Clients are typically concerned about getting the job done at the lowest price in order to maximise returns on investments, and using digital technologies and OSM is often seen as generating additional costs which clients are usually not willing to bear³². Convincing clients about the use of BIM and OSM therefore begins with winning trust. Building a trust relationship usually takes time and involves honest communication, offering reliable information about the inherent risks and the benefits associated with these innovations. It also involves meeting agreed expectations regarding the use of BIM and OSM, having mutual respect for values, and maintaining a good reputation by following contractual requirements³³.

6.1. Industry example 3: Multiplex

At Multiplex, a combination of approaches is used in order to educate clients and to present them with the business case for the use of digital technologies. Fundamental to all the strategies used is building trust. At Multiplex, building trust with clients is achieved by being transparent at the outset about the suitability of specific digital technologies for projects and their possible benefits, and by offering critical professional advice on suitability. For every project, they actively engage with clients to assess which aspects would benefit most from the use of specific digital technologies and involve them in selecting suitable technologies for the job, from an early stage in the project. This approach enables otherwise reluctant clients to see the usefulness of the technologies for their projects.

Multiplex relies on visual communication tools, including 3D modelling and virtual reality in order to demonstrate the benefits of digital technologies. Regularly updating clients on

³⁰ IPA (2016). Government Construction Strategy 2016–20. London: IPA.

³¹ IPA (2019). Proposal for a New Approach to Building: Call for Evidence. Infrastructure and Projects Authority. London: IPA.

³² http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report_.pdf

³³ Badi, S., Ochieng, E., Nasaj, M., & Papadaki, M. (2020). Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint. *Construction Management and Economics*, 1-19.

project progress using these same tools (as well as drone footage of ongoing work) helps to boost client trust and increase confidence in the use of innovative technologies for future projects.

6.2. Recommendation

Build transparent, long-term trust-based relationships with clients

Construction firms should make deliberate efforts to demonstrate the value of using digital technologies and OSM for project delivery to clients. This requires building relationships based on mutual trust over time through professional advice and clear and consistent articulation of the potential financial and sustainability gains to be made from using digital technologies and OSM. Being able to demonstrate that the promised benefits and savings were delivered is crucial to maintaining that trust.

7. Training and skills development initiatives for employees

Employees need to be supported to develop the necessary skills and competencies to enable them to engage with digital technologies and OSM. Rather than assuming a particular level of digital competency, firms need to establish a baseline of individual competencies so that employees can start their skills journey at the right level for them.

The digital competency scale provided by the CITB³⁴ is a good resource for undertaking this task as it helps to identify which groups of employees need which specific skills and competencies. The Supply Chain Sustainability School³⁵ also has a wide range of programs available for training employees at different levels of competencies.

To complement these, bespoke or one to one training which is tailored to individual digital literacy is crucial. In addition, it is useful to provide all employees with the basic skills for operating any underlying platform prior to introducing application software as part of a digital transformation programme. Companies should bear in mind that soft skills training including collaborative skills, system thinking, and communication are as fundamental as hard skills.

7.1. Industry example 4: Kier

Kier is a leading UK construction and infrastructure services company, with almost 20,000 employees³⁶, ranking second³⁷ among the UK Top 100 construction companies. This multi-award-winning company³⁸ was also shortlisted for recognition under the category of the Best Skills & Training Innovation at the Building Innovation Awards 2019³⁹.

As part of their digital competencies training, Kier provide in-house training, designed in line with Kier's digital transformation agenda. The training involves regular one-to-one meetings between BIM Coordinators and design and project employees and aims to identify digital learning needs and assign employees to learning sessions that will provide them with the requisite skills and knowledge about software, programmes and processes. These sessions are designed to take account of individual knowledge and skills. Regular drop-in sessions

³⁴ https://www.citb.co.uk/documents/research/citb_constructions_digital_future_report_oct2018.pdf

³⁵ <https://www.supplychainschool.co.uk/>

³⁶ <https://www.kier.co.uk/media/6069/2020-annual-report.pdf>

³⁷ <https://www.theconstructionindex.co.uk/market-data/top-100-construction-companies/2020>

³⁸ <https://fibointercon.co.uk/top-ten-construction-companies-uk-2019/>

³⁹ <https://buildinginnovationawards.co.uk/2019-winners/>

with refreshments encourage people to get answers to their questions and help overcome any embarrassment that might arise when asking questions in a more formal setting.

7.2. Recommendations

Upskill employees in the use of new software and adapting to modified processes

Upskilling employees is a priority for construction companies in the journey from conventional methods of working to the use of digital technologies. Attention needs to be paid to helping employees adapt to new technology-driven processes and software changes⁴⁰.

Creating opportunities for employees to take the initiative in learning about the use of digital technologies is also critical. To this end, companies should support their employees to undertake relevant training courses provided by relevant institutions, including the CITB⁴¹, British Standards Institution (BSI)⁴², Royal Institution of Chartered Surveyors (RICS)⁴³ and Supply Chain Sustainability School⁴⁴.

Provide tailored training based on employee digital competency levels

Employees need to be equipped with soft skills, and generic and role-specific competencies. Not everyone needs to know everything, but all employees should achieve competencies in the use of certain 'basic' digital platforms (e.g., Microsoft Teams, Skype and Microsoft Office). Incorporating clear competency profiles into role descriptions ensures that employees understand the skills they are expected to have and the tools they are expected to use.

⁴⁰ UK BIM Framework (2020). BS EN ISO 19650. Guidance Part 2: Processes for Project Delivery 3rd Ed. Accessible via: https://ukbimframework.org/wp-content/uploads/2020/01/ISO-19650-Guidance-Part-3_SinglePagePrint.pdf

⁴¹ <https://www.citb.co.uk/courses-and-qualifications>

⁴² <https://www.bsigroup.com/en-AE/Our-services/Training-courses/BIM-Training-Solutions/BIM-Processes--Procedures-Training-Course/>

⁴³ <https://academy.rics.org/>

⁴⁴ <https://www.supplychainschool.co.uk/topics/bim/>

8. Robust structures for effective collaboration and communication

As construction firms seek to make more use of BIM and OSM, they need to establish new ways of communicating that facilitate greater collaboration and the sharing of data and information⁴⁵.

Collaborative work (e.g., design and model analysis) based on shared information systems requires changes to traditional work practices and routines; these become more complicated where multiple firms work on a project⁴⁶.

Collaborative design practices require different professionals coming together to work together in cross-functional teams⁴⁷. Firms should aim to develop team structures that place less emphasis on control and strict differentiation in the functions of teams (e.g., IT analysts, designers, project managers). Rather, creating cross-functional teams with structures that promote freer communication encourages collective creativity in problem solving and encourages employees to take the initiative when working with new tools, technologies or implementing new processes. Teams need to work with software platforms that can 'talk to each other' and are interoperable as easy communication can reduce the likelihood of conflicts and enhance collaboration.

Effective collaboration and communication using BIM are not compatible with traditional methods of organising and sharing information, such as physical files, and construction firms will need to change their systems of data capture, storage and sharing of quality data. Implementing changes to how data is captured, shared and stored should be preceded by the dissemination of clear documentation in a digital format. This should set out the deliverables and data expected from each department inside the firm and from each party in the project supply chain. Construction firms need to embrace electronic means of sharing information in order to facilitate seamless work with others effectively across multiple teams. Guidelines for data integrity and accuracy need to be established, as well as clearly defining the responsibility of each employee regarding data input and security. Putting such

⁴⁵ Papadonikolaki, E., van Oel, C., & Kagioglou, M. (2019). Organising and Managing boundaries: A structural view of collaboration with Building Information Modelling (BIM). *International Journal of Project Management*, 37(3), 378-394.

⁴⁶ Tee, R., Davies, A., & Whyte, J. (2019). Modular designs and integrating practices: Managing collaboration through coordination and cooperation. *Research policy*, 48(1), 51-61.

⁴⁷ Wensveen, M. (2019). How organizational structure contributes to digital transformation. *Forbes*. Accessible via: <https://www.forbes.com/sites/forbestechcouncil/2019/09/19/how-organizational-structure-contributes-to-digital-transformation/?sh=6ade2ba23091>

protocols in place is essential to establish new practices and greater collaboration and communication that will support wider use of BIM and OSM.

8.1. Industry example 5: ISG

ISG, one of the world's most dynamic construction services companies, is ranked 7th in the UK Top 100 construction companies⁴⁸, and was the winner of the Construction News Award 2018 for Supply Chain Excellence⁴⁹. Their 2,800 worldwide specialists in fit out, technology, and construction deliver buildings in Europe, the Middle East and Asia.

To facilitate effective communication, ISG operate a 'horizontal structure' that has two senior managers leading two teams of twenty-four members. This structure enables BIM managers, BIM coordinators and BIM technicians to raise different issues among themselves and to support each other as well as other stakeholders. As part of this structure for communication, employees write weekly reports to a senior manager about the challenges they have encountered when using BIM or other digital technologies.

Teamwork is fundamental to ISG's digital strategy, and employees are encouraged to communicate with each other regularly. Quarterly gatherings allow employees to share information with colleagues about projects, about new technology or software being used, or about challenges faced.

To ensure effective communication with firms in their supply chains, ISG provides its supply chain partners with detailed documents outlining expected deliverables and timelines as part of the project communication ahead of meetings. They also hold regular meetings with their project partners to assess the deliverables at each stage and to discuss next steps.

8.2. Recommendation

Create enabling structures for effective communication and collaboration

Developing structures that will facilitate effective communication and collaboration, both internally and with supplier networks, involves the creation or restructuring of cross-functional, interdisciplinary teams. Establishing inter-disciplinary teams will enhance collaborative working and needs to be prioritised. It will have the added benefit of helping professionals from different disciplines learn how to work effectively with others using the same or similar digital tools and software. Firms need to ensure that BIM and OSM platforms

⁴⁸ <https://www.theconstructionindex.co.uk/market-data/top-100-construction-companies/2020>

⁴⁹ <https://awards.constructionnews.co.uk/2019-winners-finalists>

and systems used for design functions can 'talk to each other' in ways that do not result in any data loss, as this could lead to miscommunication and potentially create conflict. Furthermore, construction firms should convert data and information formats into digital versions for easy sharing across platforms, internally and across project supplier networks, in a timely manner and at different project stages (e.g., RIBA Stages)⁵⁰.

⁵⁰ <https://www.architecture.com/knowledge-and-resources/resources-landing-page/riba-plan-of-work>

9. Conclusion

This guidance has presented six factors, identified through research and industry examples, that are critical enablers for construction firms to adopt digital technologies and to make greater use of OSM:

- committed leadership and management;
- a digital transformation strategy with realistic objectives;
- building capable supplier networks through a 'growing together' approach;
- building trust-based relationships with clients;
- training and skills development initiatives for employees; and
- robust structures for effective collaboration and communication

The guidance emphasises the importance of having a clear digital transformation strategy guiding a journey of change, backed strongly by leaders who believe in the transformation vision and who work with and train their employees in order to achieve the goals of the vision. Building transparent, trust-based relationships with clients by offering reliable, professional advice about the use of digital technologies and OSM is also important. Building structures that enable collaboration, enhance clear communication and prioritise feedback is also crucial for construction firms seeking to successfully adopt and use BIM and OSM.

We have outlined nine key recommendations to guide construction firms in taking steps to adopt and use building information modelling (BIM) and offsite manufacturing (OSM):

- appoint a transformation leader;
- lead by example;
- lead people, don't focus solely on technology;
- design a simple, clear and people-focused digital transformation strategy that can be easily communicated;
- support your supply chain to develop their digital and OSM capabilities;
- build transparent, long-term trust-based relationships with clients;
- upskill employees in the use of new software and adapting to modified processes;
- provide tailored training based on employee digital competency levels; and
- create enabling structures for effective communication and collaboration.

Implementing these recommendations will allow construction firms to successfully make the internal changes that will allow them to adopt and use BIM and OSM for project delivery.

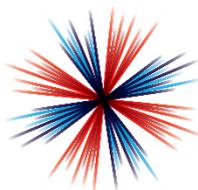


UNIVERSITY OF CAMBRIDGE

Cambridge Centre
for Housing &
Planning Research

The authors are grateful to all of the industry partners who participated in the research that informed this industry guidance. We wish to particularly acknowledge the support of the construction firms cited in this document: ISG, Kier, Multiplex, Skanska and Willmott Dixon.

This research forms part of the Centre for Digital Built Britain's (CDBB) work at the University of Cambridge within the Construction Innovation Hub (CIH) which brings together world-class expertise from the Manufacturing Technology Centre (MTC), BRE and CDBB to transform the UK construction sector. The CIH is funded by UK Research and Innovation through the Industrial Strategy Fund.



**INDUSTRIAL
STRATEGY**



**UK Research
and Innovation**