Legal Implications of Digitization in the Construction Industry

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Abstract In the current age of Construction 4.0 (construction and engineering's part of Industry 4.0), the construction industry is moving towards greater digitization and *digitalization*, i.e. leveraging the process and benefits of digitization. At present, the change is happening incrementally and has brought with it conflicting expectations and understanding of the processes, obligations, and possible consequences of moving into the digital space. Furthermore, this uncertainty is compounded by a dearth of standard contract documents, relevant standards and a general lack of understanding in the legal community of the issues, risks and processes involved. As a result, the legal and contractual impact of implementing digitization is often ignored, or kicked down the road, with vague contractual obligations becoming the norm. This attitude is to lay a risk "time-bomb" that can eventually reduce—or even eliminate completely—the time, cost and many other benefits of working in a more digital environment, whilst making clients and the industry as-a-whole more hesitant in their digital journey. We are already starting to see expensive and time-consuming disagreements and disputes resulting from this lack of clarity. This paper will consider the legal challenges of implementing digitization worldwide, and how these can be overcome to facilitate and support the continued move by the construction industry towards an increasingly digitized environment.

Keywords Legal · Contracts · Disputes · Digital · Risk

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1 Where Do We Start?

1.1 Digitization and Digitalization—What's the Difference

Digitization and digitalization have gone from a "nice to have" in recent years to a "must have". However, what are we talking about, and what's the difference? According to Forbes [1], digitization essentially refers to taking analog information and encoding it, so computers can store, process and transmit the same. Another variant of the definition underlines the fact that digitization means converting and/or representing something non-digital into a digital format which can then be used by a computing system for numerous possible reasons [2]. Put simply, digitization is about converting information into digital format. Comparatively, *digitalization* does not appear to have a consistent definition. Some commentators suggest it means turning interactions, communications, business functions and business models into more digital ones [3], or the use of digital technologies to change a business model or to transform business operations [4]. In essence, it appears that digitalization is the use of digital technologies (and digitized data) to change interactions, communications and business models making them more digital. This paper will consider the potential legal issues and risks associated with digitization and digitalization, and how these may arise within some of the most common digital technologies in use within Industry 4.0.

1.2 Why Digitization and Digitalization Matters

Digitization and digitalization have many well-documented benefits, including increasing efficiency, reducing cost and reducing time. A survey by KPMG reported that 85% of CEOs estimated that they had a two-year timeframe to implement digital transformation before sustaining adverse financial impact and/or lagging behind the competition, while a McKinsey Report found that data-driven organisations are 23 times more likely to acquire customers and 19 times more likely to be profitable compared with companies who have not adopted digital transformation [5]. A study by the Association of German Chambers of Commerce and Industry found that 93% of companies agreed that digitization would influence every one of their processes [6]. Despite this, according to the Committee for European Construction Equipment, the civil engineering and construction sector is apparently one of the world's least digitized sectors, particularly in Europe [3]. This news may not be surprising for many readers. Compared to industries such as manufacturing and automotive, construction has, in some ways, not significantly progressed from the bricks-and-mortar industry of 50 years ago.

In recent years, however, the construction industry has started the move towards becoming more digitized, and at an ever-increasing rate. This digital revolution cannot be ignored. As one commentator points out, digital technologies are

"no longer mere tools to help companies do the same things a bit better. Instead, they fundamentally change the way business is done" [7]. The speed of adoption is accelerating as the benefits become more visible, as a result of published case studies and experiences, and the potential to be left behind becomes a real possibility. Clients are increasingly requesting or specifying the greater use of digital technologies to harness the publicized benefits, even if they are not wholly familiar with them or indeed how to accurately specify their use. Organisations like the European Commission are driving innovation by funding research projects, such as Open Innovation 2.0 which seeks to create a new positive collaborative approach to innovation between government, industry, academia and civil participants [4]. The UK has similar funding drives with Innovate UK [8] and Centre for Digital Built Britain [9].

We can see this push both in the private and public sector, with clients including requirements relating to digitisation and digitalisation and government initiatives. Government initiatives often seek to both push adoption forward as well as overcome the gap in standards and legal frameworks. These include the Building Information Modelling (BIM) mandates in various countries, such as the UK and Singapore, which led to the development of specific standards and government procurement documents (see Chapter "Building Information Modelling and Information Management"). Some countries also have specific digitization strategies, such as the Dutch Digitization Strategy which considers how best to implement digital transformation, including overcoming the impact on international law and legal frameworks [10]. Digital Europe, the EU's long-term budget covering the period 2021 to 2027, has reportedly put aside €9.2 billion for technological projects —although one commentator laments that the path is still very long on the road to a confident and resilient digitized construction industry in the EU [11].

However, as found by one study of construction firms and their suppliers in Germany, Austria and Switzerland [6], the implementation of digitization and digitalization can lead to problems. Practical implementation challenges include a lack of knowledge and understanding, available guidance and standard documentation, coupled with the industry's general fear of change. Therein lies the potential for misunderstandings and, consequently, the likelihood of dispute. The potentially catastrophic effects of this fear of change was emphasized in the compellingly entitled Farmer Report: Modernize or Die [12] published in 2016.

To add to the practical problems, there is the strange dichotomy that even with greater digitization, the perception appears to be—even within the industry itself—that we are doing the same thing we have always done but using a computer. We have often been told that that nothing's really changing and therefore we do not need to revisit the legal issues and risk management. This mindset leads organisations into a false sense of security. Moreover, the logic is fundamentally flawed as digitization and digitalization result in fundamental changes in the ways of working and interacting with others in the project team. We have seen how this failure to pay attention to legal impact and risk often leads to disputes and disagreements. For example, when

parties make vague requirements for digitalization in contracts and specifications or use technological processes to create and exchange information and data, with no discussion or consideration of risk allocation until something goes wrong.

1.3 Legal Impact

All new processes and technologies necessarily bring new risks and issues, for example, due to the variety of practices, terminology and requirements. This is aggravated by the lack of standardization and common understanding between parties and across different countries. There is helpfully an increasing amount of guidance regarding digitization and digitalization. However, most of it is focussed on the technical aspects with little substantive legal or contractual guidance and/or laws, dealing expressly with digital technologies. The European Commission has issued recommendations for the development of law in the context of digitalization [13] and some countries worldwide have issued white papers and guidance on specific areas of construction technology. For example, the UK Government's white paper on drones [14]. Nonetheless, it will necessarily be some time before there will be a comprehensive legal position on the various, fast-developing technologies being used within the construction industry anywhere in the world.

The current issues and uncertainties are compounded by the frequent lack of specific legislation, standard form contracts and applied standards relevant to the specific digital processes and technologies in question. The practical implementation of digitization and digitalization within the construction industry is already light years ahead of the applicable laws, leaving legislation and contract terms playing catch-up. Clarification of the position will eventually come with case law and new or amended laws. However, in the meantime, it is important to deal with these risks of misunderstandings and unintended liability via clear contract terms and other processes aimed at mitigating these specific issues. This is not necessarily straightforward to implement due to the fragmented nature of the construction industry and lack of replication of projects and teams, as well as the adversarial nature of many construction contracts [15]. As well as contract terms implemented by parties themselves, there is also an increasing amount of guidance and standardization that could be implemented if parties choose to do so. An example of this is the international information management standard, the ISO19650 series, released in 2018 and already being widely adopted worldwide; its aim is to introduce standardization in the management of digital information. Digital exchange of information has led to a necessary need to work in a more collaborative way. This in turn has led naturally to an increase in complementary collaborative-based contracts being introduced by standard contract publishers to meet this change in ways of working and interaction, such as the New Engineering Contract ("NEC") and the Joint Construction Tribunal ("JCT"), as well as pilots of wholly new ways of contracting. One of the most well-known of the latter in the UK is Project 13, a multi-organisation movement aimed at enabling a new

operating model for enterprise working, with more collaborative working practices, and recognizing infrastructure as an information-based industry [16].

2 Common Legal Issues and Risks

2.1 Terminology, Acronyms and Jargon

New technologies seem often to bring with them a whole new language of terminology, acronyms and, some may say, jargon only understood by those involved with the technology concerned. Some of these more common terms and acronyms are set out in Fig. 1. It can indeed be an entertaining exercise to play "buzzword bingo" when listening to talks on construction technology and digitization in the industry.

However, the more serious problem is that this terminology, these acronyms and technical language may not be understood by the vast majority of the industry. This leads to misunderstandings and differing expectations when this language is discussed or inserted into contractual documents. If one feels sceptical, imagine putting a hundred digital technology specialists from the construction industry in a room and ask them to define "BIM", or a typical process for modular construction, and there will be a plethora of varied, and sometimes contradictory, interpretations. An example of this can be seen in the differing definitions for "BIM" and "BIM Level 2" given by the interviewees in the 2018 Winfield Rock Report [17].

There is a common and prevailing misunderstanding that the use of new technology and implementation of digitisation does not give rise to new legal risks, issues or obstacles. However, if your and your client's understandings are very different as to what your rights, obligations and deliverables are in regard to digital implementations in a project, the likelihood for disappointment and disagreements is self-evident.

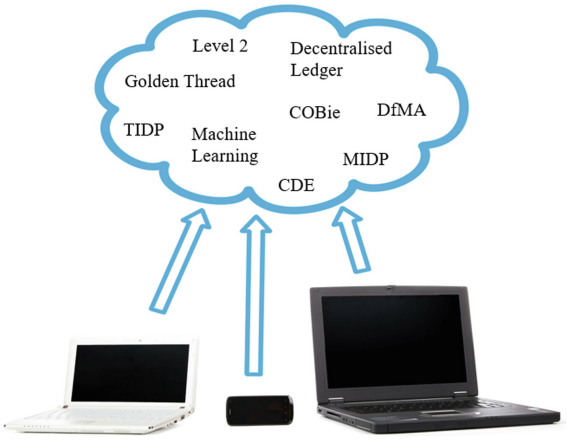

Fig. 1 New technology brings new terminology and acronyms

2.2 Binding Documents and Obligations

Given that most of the construction industry is still getting-to-grips with utilizing and applying digital technologies in their businesses and projects, the knowledge of the processes and risks within an organisation may vary widely. There may be specific, allocated teams dealing with these aspects. The review and preparation of documentation is often fragmented. The delivery of the digital aspects of a project may be similarly hived off to the digital department or team.

We are aware of numerous examples of detailed documentation setting out parties' digital and technology obligations for a project being wholly non-contractual. The teams within an organisation delivering the project may not even be aware of their existence until there is a dispute and the enforceability of the requirements in these documents is called into question. There will then be the crucial legal questions of whether parties benefit from any of the limitations and protections of their contracts when complying with these documents, which may have very comprehensive requirements as to processes and content or format of data without any detail on risk allocation if things go wrong. This is an equally important issue when parties seek payment for complying with these non-contractual documents and could find a client seeking to reject right to payment. These are complex contract law issues and could be avoided by working with a professional adviser to ensure all relevant digital documentation and detail is inserted into the binding contractual documentation in an appropriate way.

There is also the separate but related issue of the accuracy and relevancy of the digital requirements and clauses within the contractual documents. Are the contents of the client's requirements relevant or does it look like a cut-and-paste job? In one real-life example, there were tenders for three different projects for different clients, with identical Employer's BIM Information Requirements. Another time, a set of Employer's BIM Information Requirements had two pages of detailed BIM deliverables; when we asked whether these were in fact required as they seemed excessive, the client simply explained they had "no idea what any of it meant" and it was produced by a third party consultant. The blame though cannot be placed wholly at the door of those preparing the documents (and contracts) of the clients—if a client does not know precisely what they want, their advisers are limited by their instructions and interpreting these as best they can. It is often helpful to seek clarity if the documents are unclear to hopefully uncover such issues, and perhaps point them to introductory guidance and standardized documents drafted by specialists in this area. One example is the simple Part 1: Concepts ISO19650 Guidance, which is part of the UK BIM Framework [18] that the UK Government's 2020 Construction Playbook recommended be fully implemented by clients, contractors and suppliers [19].

Figures 2 and 3 contain flowcharts of the documents that the ISO19650-2 standards anticipate the need to be included or referenced within contracts to comply with the ISO19650 process. Figure 2 sets these out for contracts between a client (Appointing Party) and lead contractor or lead designer (Lead Appointed

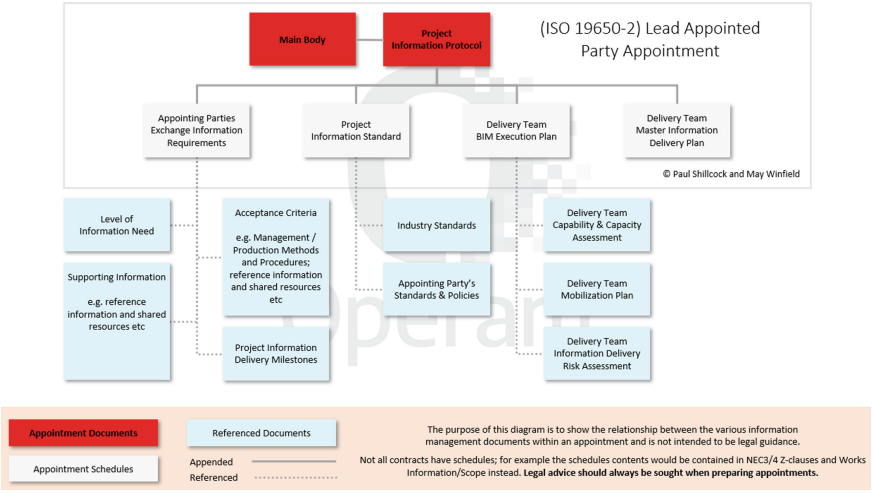

Fig. 2 ISO19650-2 appointing party-lead appointed party flowchart

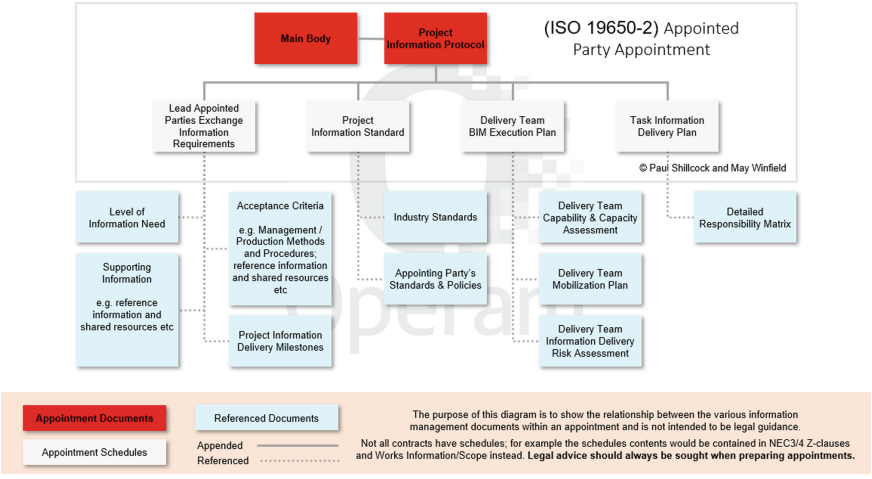

Fig. 3 ISO19650-2 lead appointed party-appointed party flowchart

Party) and Fig. 3 sets these out for contracts between a lead contractor or lead designer (Lead Appointed Party) and their subcontractors and subconsultants (Appointing Party). The flowcharts use the ISO19650 terminology and were created by Paul Shillcock (author of ISO19650-2) and May Winfield.

The UK BIM Framework also includes a standard form contract template, called an Information Protocol [18], that is (to current knowledge) the first contract template document that is fully compliant with the international standards,

the ISO19650 series. The ISO19650 series anticipates and requires that the contract documentation includes a contract schedule or appendix, i.e. an Information Protocol, which sets out how the parties will comply with the ISO19650 requirements from a legal perspective and incorporates or refers to all the relevant documents required to be created by the standards such as the Exchange Information Requirements, Project Information Standards and BIM Execution Plan as well as the vital information or resources central to the processes envisaged by the ISO19650. Such information and resources include, for example, the Level of Information Need specified by the client. The Part 1 and Part 2 Guidance available on the UK BIM Framework website provide further explanation on these various terminology and documentation [18]. Whilst the Information Protocol available on the UK BIM Framework website is drafted for UK law, given the current absence of other equivalent documents in other jurisdictions implementing the ISO19650 series, it would serve as a useful basis or example for those drafting contracts that seek to require compliance with the ISO19650 standards.

Where digital and technology processes and requirements are vague or open to interpretation, collaboration and open discussion becomes vital if added clarity in the contractual documents itself is not a possibility. However, there is one qualification to that. The moving nature of the construction industry means that the person one is having discussions with now may not be the same person considering the issues several years from now who will need to rely on the written documentation. Records at this point become very important to minimize the chance of long-running misunderstandings, although they cannot of course replace the certainty afforded by clear contractual documentation.

2.3 Copyright and Ownership

All contracts will usually contain a copyright or intellectual property clause. Whilst these are often widely drafted to capture all types of documents, models and other forms of data, they may set out the same ownership rights for all the documents and data (frequently defined collectively as “Materials” or similar), only differentiating between background (i.e. existing before the services/works) and foreground (i.e. creating during the services/works) intellectual property. This may be because those drafting the contracts may not be aware, through no fault of their own, that some of the types of digital data need to have different ownership allocations. This is because the digital data being exchanged now often comes from different sources, for example, a party’s own data, its supply chain’s data or data obtained from third parties. The latter may consist, for example, of digital tools, templates or objects within models.

The greater connectivity, transparency and co-creation or collaborative digital environments can consequently lead to copyright or ownership confusion and issues. As an example, a designer would usually not have the right to assign copyright of a manufacturer’s objects within its model to a client; the designer itself

is likely to only be using these under licence. They will therefore be in breach of the copyright clause which seeks to ownership in all intellectual property to a client. As well as being in breach of contract, this may also cause unexpected problems for the client, depending on the intended use by the client of the models and whether, for example, the manufacturer may raise objections and requests for licence fees.

New digital processes may produce new types of data or new products. Take modular construction as an example. There is the original design, that is then developed by the modular manufacturer, and then the modular panels themselves. Is it clear who has ownership (and therefore responsibility) for each element or when this ownership may pass over to another party?

In the current economic environment, insolvency is also a relevant consideration. Does the documentation make it clear where intellectual property sits for the digital technologies and resulting data and products, in the event of insolvency or indeed, on normal contractual termination? [20].

2.4 Process and Data, Including Confidentiality

Digitization and digitalization are, at their heart, primarily about process and data. Due to how new the introduction of digitization still is within organisations and indeed the construction industry generally, there will necessarily be a lack of standardization of processes and procedures, such as naming conventions, checking processes and security protocols.

Whilst a party may be confident in its own organization's security and checking processes, is it equally comfortable that the same levels are upheld by the rest of the design team (who may hold copies of the party's models and other data) without specific processes being agreed? Is it confident of the integrity of the data it receives? Who will have access to the shared data storage system; will staff be prevented from sharing login access?

Is it clear how parties should share updated data, and how they will be notified of such updates? What rights does a party have over the data it receives, either directly or via digital technologies within its control (e.g. drones, robots and cloud storage)? Are there appropriate back-ups of the data stored to avoid delays and additional costs of data loss or file corruptions? Where will the data be stored, and who is responsible to set up and maintain this storage and data exchange system, and ensure parties use it as intended? Have sufficient steps been taken to avoid cyber risks like hacking?

There is then the separate and recognized issue of interoperability. One way to explain this issue of interoperability, which is rooted in the compatibility of files created in different software, as akin to writing a document using a proprietary software on a Mac and then opening this same document on a different proprietary software on a PC. Some formatting may have changed but there is no big flashing red light to warn one of this. Similarly, models and other data may look or behave

differently when viewed on different software. There are various steps that can be taken to mitigate the issues of interoperability and it seems sensible to set these out from the outset with the other parties involved.

2.5 Who is Responsibility for What

Digitization and construction technology seems to have brought a whole host of new roles. Digital manager, BIM champion, BIM lead, information manager and more. However, from a legal or contractual perspective, there is no magic in declaring these roles without further detail. At the time of writing, there is no universally agreed scope for the various new roles required and allocated. In the same way as the risks of using other undefined terminology, could parties have different understanding what an information manager should do, as an example; should it include managing the project team's compliance with processes or simply managing the information itself?

It is also important to ensure all the various new tasks and requirements are allocated to avoid gaps or problems due to uncompleted activities. This could range from how data is to be produced, named and exchanged, change management, and risk allocation for errors or other foreseeable issues. The new international BIM standard, ISO19650 series, recognizes this and helpfully sets out parties' respective tasks in considerable detail in a bid to avoid such issues in the area of information management of digital data.

There is also the vital issue of health and safety. Technologies can be used to improve health and safety (see Chapter "Emerging Technologies for Health, Safety and Wellbeing in Construction Industry"). However, if technologies are being relied on to detect health and safety risks or where the technologies could *cause* new potential health and safety issues (e.g. robots interacting with people on site), have sufficient and appropriate safety policies been set out in the documentation and clear obligations to ensure health and safety is maintained and achieved?

2.6 Insurance

In the brave new world of digitization and digitalization, and generally with a greater use of technology within the construction industry, the potential risk of increased or different liabilities must be considered. Unquestionably connected to this is whether one has appropriate and sufficient insurance cover if such liabilities arise.

There is no harm in discussing the intended digital and technology adoptions and processes with one's insurance broker to ensure there is adequate cover. Equally enquiring whether one's supply chain has done so. Do parties have cyber risks cover, and cover for any data management or other data handling obligations it is

taking on outside its normal role as an architect, engineer or other consultant? Can the smaller suppliers provide the required levels of cover or do alternative mitigation steps need to be taken if they are unable to do so?

3 Applying These Issues to Common Construction Technologies and Processes

3.1 Building Information Modelling (BIM)

The acronym "BIM", and the common reference to "Level 2 BIM", are good examples. As mentioned above, the 2018 Winfield Rock Report [17] discussed how all its construction industry interviewees provided different definitions for both. If such terms are then used in a contract without a contractual definition (such as simply specifying a party must "deliver Level 2 BIM"), it is almost certain that both parties will have different understanding of how this obligation should be fulfilled. Details of Building Information Modelling (BIM) are provided in Chapter "Building Information Modelling and Information Management".

The ISO19650 series has arguably added an extra layer of complexity to this. It removes references to "Levels" in favour of "Stages" and introduces an overall standard of "BIM according to the ISO19650 series". Section 4 of ISO19650-1 defines this standard as meaning "Where a mixture of manual and automated information management processes are used to generate a federated information model. The information model includes all information containers delivered by task teams in relation to an asset or a project". However, this lacks the necessary precision and detail by itself to clarify how parties carry out BIM "according to ISO19650 series"—What processes need to be used? What should be contained in the federated information model? Who has responsibility and ownership for it?

In the day to day, it is very common to find roles with "BIM" referenced, including BIM manager, BIM information manager, BIM co-ordinator, BIM lead and BIM champion. Without a contractual definition or an industry definition, e.g. via standards, and detailed scope, what are parties' roles, duties and rights when appointed these roles.

In a BIM model, there are four main elements from a copyright or intellectual property perspective, namely the model itself, the design, the objects and any other data contained in or generated from the model. How the ownership of each element should be allocated may differ from project to project depending on the requirements and intentions of the parties. If this is not reflected in the contract, could disputes arise as parties find they do not have the ownership or use licences they had expected?

3.2 *Drones*

Drones have come into the public's consciousness as small drones become an affordable gadget, and there have been a few well-publicized and controversial incidents involving privately owned drones [21]. Many countries now have regulations and laws governing the use and ownership of drones. For example, in the UK there is, among others, the Civil Aviation Act, Air Navigation Order 2016 and the guidelines of the Civil Aviation Authority, which is tasked with issuing licences and permissions for commercial use of drones. However, the laws and regulations may vary considerably between jurisdictions and parties would need to ensure they, and their drone operator if not local, are sufficiently familiar with all the restrictions and requirements.

One commentator asserts that drones are going to be a major disruptor in the construction industry now and in the coming years, with early adopters gaining an edge in a very competitive market [22]. There are many potential uses for drones within the industry, as discussed in Chapter "Reality Capture: Photography, Videos, Laser Scanning and Drones" of this book. If parties do decide to use a drone on site without planning or contractual risk allocation, it might not be clear who should be liable if something goes wrong. Who has the responsibility of getting all necessary licences and permissions, and bears the risks of costs for trespass across neighbouring property without permission (a greater practical risk in heavily congested areas) and breaches of personal data protections in taking footage of passers-by or site visitors? What if something falls from the drone and causes personal injury or property damage? Who bears responsibility and whose insurance policy responds?

What if the drone does not capture the intended visuals, or the data gets corrupted or lost when being downloaded from the drone? What responsibilities and liabilities does the drone operator bear, and which are retained by the employing contractor, consultant or client? Does the drone operator have all the necessary licences and compliance with any other training or other requirements of the authorizing body? If the drone operator comes from a different country, they may need additional local authorizations.

Drones capture data on site, which means there is a risk of recording the movement of individuals, which is categorized as "personal information". The statutory instruments dealing with personal data, like the General Data Protection Regulation ("GDPR") in the EU, may be relevant to the data use and storage of drones due to the possibility of capturing images of individuals, be they employees, visitors to site or members of the public near the site, and it is sensible to discuss this with those dealing with personal data issues within an organisation.

From various seminars attended and articles read by the author, insurers appear to still be getting up to speed with the issues posed by this new technology. Some typical insurance coverage issues highlighted by various insurers the writer has either heard speak, or has spoken to, include the lack of aviation experience of the insurers leading to a perceived greater risk of accidents or damage, as well as the potential lack of experience of the insurance brokers themselves in matters of

aviation. Insurers also appeared concerned about the difficulties in ascertaining the acceptability and durability of the drones used, with technology progressing all the time and new models superseding old. Also, cited were difficulties of monitoring that the correct and sufficient approvals and permissions continued to be obtained for the drone use in a rapidly evolving regulatory environment. Eventually some of these concerns may be resolved by drone-specific insurance policies or simply reduced as parties become more familiar and comfortable with the use of drones.

For further details regarding the issues arising from the use of drones and how to mitigate them, a longer paper on this topic may be helpful [23].

3.3 Design for Manufacturing and Assembly ("DfMA") and Modular Construction

As a starting point, it is worthwhile to consider whether the split of rights and obligations is consistent and reflective of parties' intentions throughout the suite of contracts between the parties, e.g. the employer, contractor, consultant and manufacturer, particularly that there is no gap in rights or duties. Are the binding contractual terms clear on who is responsible for the manufactured components at each stage of the process? How far are the contractor and consultants responsible for the manufacturer's interpretation of their design and the subsequent manufacture and assembly, particularly if the results are not as envisaged? Equally, is it clear who is responsible for any additional costs and delay due to interoperability issues arising as a result of the different software platforms used by the parties?

Issues such as the correct programme to be complied with for manufacture and assembly (see Chapter "Cyber-Physical Construction and Computational Manufacturing"), and responsibility for interpretation and application of the design, can be complex matters that could cause friction between parties without clarity at an early stage. Who is responsible for damage during storage, in transit and during construction? Do the relevant responsible parties have insurance cover for such damage? Is there clarity on who is responsible for insuring the components at each stage? What about responsibility for failure in quality or KPIs due to untrained assembly of the components on site, e.g. does the manufacturer have express obligations to provide sufficient assembly guidance? Indeed, on a related issue, when setting out the KPIs for the components within the contract documents, are parties comfortable that these are both measurable and achievable?

One important area that will no doubt be of great concern will be ownership. This includes ownership during manufacture and during transit, and clarity on when this ownership (and risk) passes. Are the contract terms clear on this, e.g. will it pass on payment or on delivery? The JCT Standard Form of Building Contract (both 2011 and 2016 editions) contains an example of a retention of title clause that deals with off-site materials; it provides for payment in respect of materials stored off-site and title to pass provided that certain conditions are met.

Some parties may require payment to be backed by a vesting certificate or bond to protect passing of title or ownership. An employer may want to ensure that the manufacturer (if not contracted directly with them) does not have any unexpected retention of title over the manufactured components.

Given how new the technologies and processes are, it will no doubt be important to ensure binding clarity and consistency of testing and checking regimes (both at the manufacturing facility and on site) and sufficient (but reasonable) rights to visit the facility to carry out inspections on quality and progress. Where a project is using multiple manufacturers for different components, standardized risk assessments and quality management or testing and checking regimes could provide important reassurance and speed-up compliance checks. Arguably, the manufactured components would be regarded as "goods" under some legislation, such as the UK's Sale of Goods Act and Supply of Goods and Services Act [24] so that the implied warranties of satisfactory quality and fitness for purpose apply; other jurisdictions may have similar legislation. Whilst employers may understandably require warranties as to quality of the components (given the limited evidence of durability of the components at present), parties will equally need to obtain specialist legal advice on the impact of these statutory implied terms, and discussions had with their insurance broker, on whether they give rise to any insurance coverage concerns.

Due to the nature of offsite manufacturing, the contract terms on this would no doubt have to take into account the length of the design and fabrication process such as in appropriate circumstances, reasonable allowances for price inflation. Would advance payment be required by the manufacturer, although backed by corresponding advance payment bonds and possibly a project bank account?

Whose insurance policy responds in the event of an issue, and how does the use of Design for Manufacturing and Assembly ("DfMA") or modular construction impact the parties' or the project's insurance cover? Does the insurance broker regard it has any impact on a project specific insurance cover or latent defects insurance cover? This technology appears to be leading to the development of new types of insurance cover to recognize this new way of working. The UK's Buildoffsite Property Assurance Scheme (BOPAS) has created a risk-based evaluation which demonstrates to funders, lenders, valuers and purchasers that homes built from non-traditional methods and materials will stand the test of time for at least 60 years [25].

3.4 3D Printing

Many of the issues regarding DfMA and modular construction apply in some part to 3D printing (see Chapter "Cyber-Physical Construction and Computational Manufacturing"). In particular, 3D printing is pushing the established legal position, and parties understanding, of copyright. Who owns the 3D printing code, and what rights are there to exploit the technology developed as part of one's services

for future projects? There is also the important issue of liability. 3D printed materials necessarily have not been subject to long-term testing; what if a component fails? Without clear contractual terms, does the liability fall on the designer, the 3D manufacturer, the software or the 3D printer? This could foreseeably lead to a long, drawn-out dispute if the contracts between the parties were silent on the issue.

3.5 Robotics and AI

When we talk about artificial intelligence (AI) (see Chapter "Artificial Intelligence for the Built Environment"), what are we actually referring to? Deloitte's simple definition may be the most helpful in this context, which explains that AI is "the theory and development of computer systems able to perform tasks that normally require human intelligence" [25].

There are other terms used in conjunction with AI, such as machine learning, deep learning and natural language processing. This leads to the first issue of terminology. Like with BIM, there is a noticeable lack of consistent agreement on the definitions of, and processes surrounding AI. In practical terms, this means that if one's contract simply requires one to "use AI" or "apply machine learning" to one's processes, there may be different understanding between a party and their client as to what this involves, what it is intended to achieve, and where liability lies if there is an issue.

What happens if the robots (see Chapter "Cyber-Physical Construction and Computational Manufacturing") with AI capabilities cause property damage or personal injury? What if machines with AI capabilities cause delay or additional costs to a project? Who bears the liability for this? Can it be ascertained who is responsible for errors caused by the AI functions, is it the original creator or the various users? This could be a complicated dispute without pre-agreed binding risk allocations. There is an increasing movement towards establishing a regulatory framework for AI. There are apparently even proposals in some jurisdictions to recognize robots as subjects of rights and obligations and even to consider them as agents in entering into contracts on behalf of their owner [26]. This is likely quite far from being in place in most jurisdictions, however, until laws are in place to clarify the legal standing of robots. For example, in Arizona, delivery robots have the same legal rights as pedestrians, but also need to abide by the same rules, and Utah is considering a bill with the same wording [13].

Robots and machines with AI functions and capabilities will likely have some form of microphone and camera. Organisations will need to ensure any applicable statutory and regulatory restrictions are complied with for any necessary personal data collected [20].

There is then the issue of intellectual property. Who benefits from a robot's or AI's learning and improvements due to its involvement in a project, bearing in mind this learning could have financial value? Who owns the data collected and products

by the robots and machines with AI capabilities? Who owns the robot or machine with AI capabilities? Did a party purchase both the physical robot or machine as well as the software and coding, or are they intended to simply have a restricted licence for the latter? Do they have a right to give sub-licences to their supply chain to enable them to utilize the technology during the project?

3.6 Cloud Computing and Big Data

Using a cloud-based platform (see Chapter "Big Data and Cloud Computing for the Built Environment") is not simply a matter of moving data from the hypothetical cardboard box of someone's IT systems to the new box of a remote server. There are resulting changes in processes and requirements whenever there is a move to something so different in form and function from what was used prior. This in turn leads to new risks, liabilities and tasks that need to be allocated or filled. To take an example: a party provides access to its cloud storage system to its supply chain or client. There are subsequent problems with access or corruption of documents, with consequential delays or additional costs incurred. The question then becomes: who bears liability for this if the documentation is silent? Was it simply something parties had not considered and therefore not discussed? Can a party withdraw access to another party at its convenience, as occurred in the UK court case of *Trant v Mott Macdonald* [2017] EWHC 2061 (TCC) [27] when the BIM Information Manager, Mott Macdonald, withdrew the contractor, Trant's access to the Common Data Environment due to a payment dispute? It is understood that the unsigned contract documents were silent on this issue leading to an expensive, and time consuming, court case.

One should not underestimate the importance of setting out the roles, rights and responsibilities in the use and access of the intended cloud-based platform in binding contractual documentation. In the event there is an issue, the documentation will clarify parties' position and rights, so they can then progress accordingly rather than argue back and forth over the point. From experience as a construction lawyer, it is the matters on which one is silent—the gaps in the documentation—that end up being disputes, as each party's perspective will almost always be different and personal. Furthermore, one cannot only rely on the conversation one is having with the other party now; given the nature of the industry the likelihood is that a different individual will be considering this later.

In most cases, legal or professional advisor is unlikely to be familiar with the functioning and processes of the cloud platform in use. They may rely on their industry client to instruct them on the real issues and risks that need to be dealt with and clarified, so they can then incorporate this into the contractual documentation. But how does a party create that list of issues and risks? Figure 4 provides a sample checklist of practical processes to implement to support the enforceability and intentions of the contractual provisions, with the aim to minimize risks of internal data sharing and external data sharing on cloud platforms.

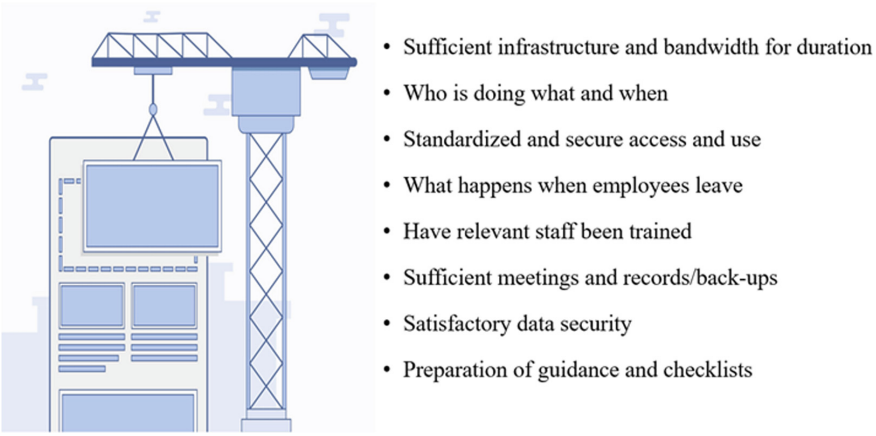

Fig. 4 Sample process checklist

Apart from risk, roles and liability generally in the use of the platform itself, there may be other obligations and contract terms that have consequential impact on the use of a cloud platform, such as GDPR (if personal data is being stored on the cloud platform) and any contractual restrictions on the location of data storage (bearing in mind the cloud servers will be physically contained in specific countries).

For those interested in this area, this topic is considered in detail in [28].

3.7 Smart Contracts

Humans, and even computers, are not infallible. Who takes responsibility in the event of human input error or coding bugs? As with written contracts, a question will also be whether the computer code actually reflects the intentions of the parties?

In their current form, are smart contracts (see Chapter "Blockchain Opportunities and Issues in the Built Environment: Perspectives on Trust, Transparency and Cybersecurity") capable of measuring performance or ascertaining when a standard of care has been achieved, so payment can be made, or other automated activity commenced? It may be that the level of human interaction or input has to be clearly decided at the outset to allow for such circumstances.

Until there are case law and/or regulations in this area, the legal standing and interpretation of smart contracts remains to be determined. Would a court regard a smart contract as a computer code enforcing the written contract, or as a contract in its own right? This could have considerable impact on the interpretation and enforceability of the smart contract. Staying on this point, given the electronic

nature of smart contracts, in the absence of a written contract specifying which laws and jurisdiction applies, could the smart contract span across jurisdictions with confusion on what law applies? Which laws and jurisdiction applies could impact the enforceability or interpretation of the smart contract. This includes, for example, any restrictions regarding personal data contained within the data making up the smart contract.

Whilst smart contracts are hack resistant, it is also worth bearing in mind that they are not entirely hack proof. In 2016, there was a $55 m ether drain hack of the DAO. This incident also illustrated complexity of legalities of smart contracts; the hacker asserted in a statement that his actions were legal as the smart contract had permitted it. Namely that his action would be illegal in a normal contract but were permissible under this contract. He went so far as to threaten legal action if actions taken to reclaim the sums. Such kinks clearly need ironing out. For those interested in this area, there are several publications and events of the Construction Blockchain Consortium [29].

4 What Now

4.1 A Non-Exhaustive Checklist

Start with a blank piece of paper. List all the things that could realistically go wrong or cause problems in implementing the intended digitization or digitalization within your organisation or particular project. Talk to your professional advisers—Have all these risks been allocated, dealt with or mitigated satisfactorily, e.g. via contract terms, process, insurance or other steps?

Think about what terminology or acronyms are being used in the documents. Do they all have defined meanings? Will someone picking up the documents in 5 years from now have the same understanding of roles, rights and responsibilities as the original authors of the documents? Are these roles, rights and responsibilities set out in binding contractual documents? Putting it simply, will parties know who is doing what, when and how?

Equally importantly, what does the client want? Is this clear and is it reasonably achievable? Is there scope for development and change in the scope as the technologies may develop or parties' understanding, and requirements change with greater understanding of the digital technologies?

Finally, are appropriate records being kept? If questioned, could a party evidence what data was issued? Are there appropriate back-ups to guard against data loss? Have staff had sufficient training to know how to implement the digital processes and where to store different types of digital data, e.g. confidential trade secrets? Figure 5 provides a suggested starting list of issues to consider in risk managing the potential legal and contractual issues mentioned above.

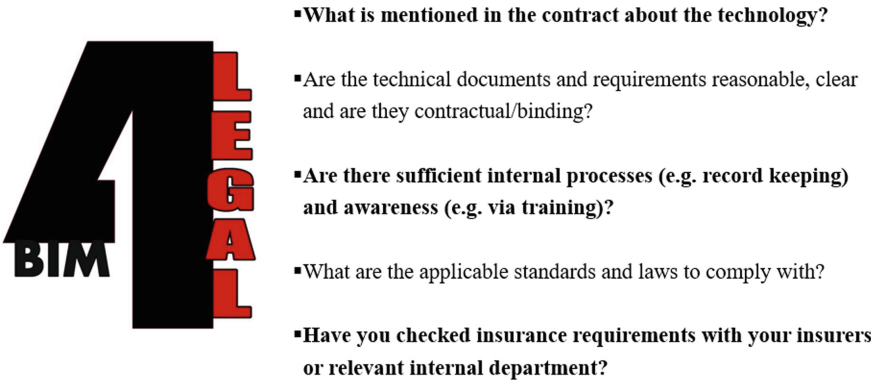

Fig. 5 Checklist of risk management issues

4.2 Final Thoughts

The future of the construction industry—and increasingly its present—is digital. Ignoring the consequential legal and contractual issues and risks will lead to misunderstandings, differing expectations and potential disputes. The longer-term clarity brought by legislation and case law will take time and is unlikely to be uniform across the world. The global construction industry cannot wait for this, and for now, clarity within documentations and clear risk-managed processes make sense.

A 3D model cannot tell a party whether it was built with reasonable skill and care, but a contract can tell them who should have made sure it was.

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